NAVAL AIR WARFARE CENTER AIRCRAFT DIVISION
PATUXENT RIVER, MARYLAND

REPORT OF TEST RESULTS

REPORT NO: NAWCADPAX/RTR-2001/17

BOEING 767 PROXIMITY EVALUATION WITH F/A-18C AND S-3B AIRCRAFT

by

LCDR M. Guidry, USN
Maj. S. Whitley, CAF
Mr. B. Markowich

30 March 2001

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DEPARTMENT OF THE NAVY
NAVAL AIR WARFARE CENTER AIRCRAFT DIVISION
PATUXENT RIVER, MARYLAND

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RELEASED BY:

30 Mar 2001

STEPHEN E. CRICCHI / 4.11C1 / DATE
By direction of the Head,
Test and Evaluation Engineering Department
Research and Engineering Group

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

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1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
30 March 2001	Report of Test Results	22 and 23 June 2000

4. TITLE AND SUBTITLE

Boeing 767 Proximity Evaluation with F/A-18C and S-3B Aircraft

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

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5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Naval Air Warfare Center Aircraft Division
22347 Cedar Point Road, Unit #6
Patuxent River, Maryland 20670-1161

8. PERFORMING ORGANIZATION REPORT NUMBER

NAWCADPAX/RTR-2001/17

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Naval Air Systems Command
47123 Buse Road Unit IPT
Patuxent River, Maryland 20670-1547

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

The Boeing Company participated in the Future Strategic Tanker Aircraft program which was intended to provide aerial refueling and aerial transport capability to the United Kingdom Royal Air Force under a Private Finance Initiative. Boeing contracted NAWCAD Patuxent River, Maryland, under a commercial service agreement to determine if an area of acceptable wake turbulence existed in the proximity of a 767 aircraft in order to perform the aerial refueling mission. This was accomplished by evaluating the 767 aerodynamic and wake turbulence effects on two receiver aircraft (F/A-18C and S-3B) at locations behind the 767, which approximated potential aerial refueling engagement areas. During the period of 22 and 23 June 2000, three F/A-18 and three S-3B flights were flown totaling 5.8 F/A-18 flight-hours, 6.7 S-3B flight-hours, and 12.5 767 flight-hours. A Lear 35 cinematography aircraft was used to document test results. The test program consisted of proximity evaluations only with no aerial refueling pods installed on the 767 aircraft and no receiver-to-"tanker" engagements. All flights were conducted within the Patuxent River restricted or local warning areas. At the positions evaluated, areas of acceptable wake turbulence existed for the F/A-18C and the S-3B in the proximity of the 767 aircraft in order to perform the aerial refueling mission. Recommend that testing continue to evaluate the 767 tanker aircraft.

15. SUBJECT TERMS

Aerial refueling (AR); proximity; wake survey

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			19b. TELEPHONE NUMBER (include area code)
Unclassified	Unclassified	Unclassified	SAR	75	Brian Markowich (301) 757-3283

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39-18

SUMMARY

The Boeing Company participated in the Future Strategic Tanker Aircraft program which was intended to provide aerial refueling and aerial transport capability to the United Kingdom Royal Air Force under a Private Finance Initiative. Boeing contracted NAWCAD Patuxent River, Maryland, under a commercial service agreement to determine if an area of acceptable wake turbulence existed in the proximity of a 767 aircraft in order to perform the aerial refueling mission. This was accomplished by evaluating the 767 aerodynamic and wake turbulence effects on two receiver aircraft (F/A-18C and S-3B) at locations behind the 767, which approximated potential aerial refueling engagement areas. During the period of 22 and 23 June 2000, three F/A-18 and three S-3B flights were flown totaling 5.8 F/A-18 flight-hours, 6.7 S-3B flight-hours, and 12.5 767 flight-hours. A Lear 35 cinematography aircraft was used to document test results. The test program consisted of proximity evaluations only with no aerial refueling pods installed on the 767 aircraft and no receiver-to-"tanker" engagements. All flights were conducted within the Patuxent River restricted or local warning areas. At the positions evaluated, areas of acceptable wake turbulence existed for the F/A-18C and the S-3B in the proximity of the 767 aircraft in order to perform the aerial refueling mission. Recommend that testing continue to evaluate the 767 tanker aircraft.

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INTRODUCTION

BACKGROUND

1. The Boeing Company participated in the Future Strategic Tanker Aircraft (FSTA) program which was intended to provide aerial refueling (AR) and aerial transport capability to the United Kingdom Royal Air Force under a Private Finance Initiative. The Boeing 767-300ER aircraft were among the platforms being offered for the FSTA program. Boeing wanted to evaluate the 767 wake turbulence prior to installing an AR system. NAWCAD Patuxent River, Maryland, was tasked and funded under a private party Test and Evaluation Commercial Service Agreement (CSA), reference 1, to provide engineering and flight test support to determine if an area of acceptable wake turbulence existed in the proximity of a 767 aircraft in order to perform the AR mission.

PURPOSE OF TEST

2. The purpose of this evaluation was to determine if an area of acceptable wake turbulence existed in the proximity of a 767 aircraft in order to perform the AR mission. This was accomplished by evaluating the 767 aerodynamic and wake turbulence effects on two receiver aircraft (F/A-18C and S-3B) at locations behind the 767, which approximated potential AR engagements.

DESCRIPTION OF TEST AIRCRAFT AND EQUIPMENT

3. Boeing 767-300ER Jetliner Airplane. A Boeing 767-300ER Jetliner, provided by British Airways (BA), was the aircraft used for these tests. The aircraft (S/N 25203) was one of a number of BA aircraft that may be converted to a tanker for FSTA use. The aircraft was powered by two wing-mounted Rolls Royce RB211-524H engines that provided approximately 60,000 lb of thrust each. Maximum takeoff weight was 400,000 lb and the maximum landing weight was 300,000 lb. Maximum fuel load was 162,000 lb. The aircraft was marked on the wings and fuselage to assist the receiver pilot in position keeping while flying in the proximity of the 767 aircraft. No AR system was installed on the 767 aircraft.

4. F/A-18C Airplane. The F/A-18 was a high-performance, twin-engine, supersonic strike-fighter manufactured by Boeing for land-based and carrier-based operations. Moderately swept wings, twin vertical stabilizers mounted forward of the horizontal stabilators, and wing leading edge extensions mounted forward on the fuselage, characterized the airplane. No aircraft instrumentation was required to support these tests. The aircraft used for this evaluation was BuNo 163476. This aircraft was considered fleet representative for the purpose of these tests.

5. S-3B Airplane. The S-3B airplane was a high-wing, jet powered, twin-engine, carrier-based multimission aircraft equipped with folding wings, folding vertical fin, launch bar for catapult takeoffs, and a tail hook. It carried surface and subsurface search equipment with integrated target acquisition and sensor coordinating systems that could collect, process, interpret, and store antisubmarine warfare/antisurface warfare sensor data. It had a direct attack capability with a

variety of armament. The A/A42R-1 Aerial Refueling Store could be carried on the port wing station (WS5). The test aircraft was S-3B BuNo 160607, since this was the only S-3 aircraft at Patuxent River capable of VHF communication with the 767 and Lear 35 aircraft. This aircraft was considered fleet representative for the purpose of these tests.

6. Cinematography Airplane. Boeing contracted with Clay Lacy Aviation (CLA) to provide aerial cinematography of the proximity evaluation. The Lear 35 had two pod-mounted turbofan engines mounted on the sides of the rear fuselage and its swept back wings had hydraulically actuated, single slotted flaps. The aircraft was configured with a weather radar and a tactical air navigation system, as well as VHF radios. All of CLA's cinematography aircraft were equipped with an ASTROVISION camera system, which consisted of three camera positions. Two ports were periscope-type mounts that protruded 4 in. above and below the aircraft. Each periscope could rotate a full 360 deg and tilt 44 deg. Each periscope mount has an Arri 35mm motion picture camera attached and can accept a variety of lenses. The aircraft also incorporated a nose camera for point of view photography. The cinematography aircraft was mandatory for the proximity evaluation to provide visual recording of the test events. Authorization for CLA to use photographic equipment for these tests was provided by the NAWCAD Patuxent River Photographic Imaging Services Department.

7. Test Aircraft Modifications/Instrumentation. No receiver aircraft modifications or instrumentation was required for this evaluation. To aid in the documentation of aircrew comments however, the F/A-18 aircraft was equipped with a TRIDECK video recording system (120 min HI-8 tape) which was used to record head up display (HUD) video and the S-3B used a hand-held voice recorder. The 767 airplane was marked on the wings and fuselage to assist the receiver aircraft in position keeping. Drawings of the markings on the 767 aircraft are included in appendix A.

SCOPE OF TESTS

TESTS AND TEST CONDITIONS

8. The test program consisted of a proximity evaluation only with no AR pods installed on the 767 aircraft and, therefore, no receiver-to-"tanker" engagements. During the period of 22 and 23 June 2000, three F/A-18 and three S-3B flights were flown totaling 5.8 F/A-18 flight-hours, 6.7 S-3B flight-hours, and 12.5 767 flight-hours. Different 767 and receiver gross weight (GW) conditions were flown to evaluate their effects on S-3B and F/A-18C flying qualities. All tests were conducted during straight and level flight. All flights were conducted within the Patuxent River restricted or local warning areas. The detailed methods of test and the test matrix are presented in appendices B and C, respectively. Flight tests were conducted within the guidelines of the Naval Strike Aircraft Test Squadron and Naval Force Aircraft Test Squadron standard operating procedures.

FLIGHT TEST ENVELOPE

9. All proximity tests were conducted within the limits of the F/A-18A-D and S-3B NATOPS manual (references 2 and 3, respectively) and the operating limits of the 767. The primary test altitudes were 10,000 and 20,000 ft mean sea level (MSL); however, alternate altitudes between 10,000 and 20,000 ft MSL were authorized. The test envelope is detailed in table 1.

Table 1: Flight Test Envelope

Parameter	Envelope	NATOPS/Flight Clearance Limits
Altitude	10,000-20,000 ft MSL	Limits of Basic Aircraft (LBA)
Airspeed	180-270 KIAS (S-3B)(1) 180-325 KIAS (F/A-18C)(1)	LBA LBA
Load Factor	+0.8 to +1.2 g's anticipated during proximity evaluation to accommodate turns for area management (angle of bank of up to 30 deg).	LBA

NOTE: (1) The S-3B and F/A-18C AR probes were retracted for all tests.

FLIGHT CLEARANCE

10. A NAVAIRSYSCOM flight clearance was issued to authorize the F/A-18C and the S-3B aircraft to fly in the proximity of the 767 aircraft to determine if an area of acceptable wake turbulence existed to perform the AR mission.

TEST LOADINGS

11. All flights were conducted with one aircrew in the F/A-18C aircraft and two aircrew in the S-3B. No special ordnance was required to support these tests. All tests were conducted within the GW and center of gravity limitations of the F/A-18C and S-3B NATOPS manuals, references 2 and 3, respectively. The F/A-18 and S-3 receiver store station allocations are shown in tables 2 and 3, respectively. The GW ranges for the 767 and receiver aircraft are shown in table 4. The GW ranges were achieved by varying fuel load only.

Table 2: Store/Station Allocation – F/A-18C Aircraft

Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	Station 9
ARDS	Clean	SUU-62 Pylon and 330-gal. EFT	Clean	SUU-62 Pylon and 330-gal. EFT	Clean	SUU-62 Pylon and 330-gal. EFT	Clean	ARDS

Table 3: Store/Station Allocation – S-3B Aircraft

Store Station	
Left wing, Station 5	Right wing, Station 6
AERO-1D Drop Tank	AERO-1D Drop Tank

Table 4: Aircraft GW's

Aircraft	Loading	Description	Test GW
F/A-18A-D	A	Three external fuel tanks	Flight 1 - 44,000-34,400 lb Flight 2 - 45,000-33,600 lb Flight 3 - 45,000-32,800 lb
S-3B	A	AERO-1D on W5 and W6	Flight 1 - 44,000-36,500 lb Flight 2 - 42,000-37,300 lb Flight 3 - 46,000-36,700 lb
767	A	GW varied using fuel load	Flight 1 - 210,000 – 270,000 lb (53 - 65% max GW)
	B	GW varied using fuel load	Flights 2 and 3 - 280,000 – 340,000 lb (70 - 85% max GW)

TEST CONFIGURATIONS

12. All flight tests were conducted with the receiver aircraft in the cruise (CR) configuration (flaps and landing gear up, speedbrakes retracted, and power as required) with the AR probe retracted. The 767 aircraft had gear retracted for all test points. At lower airspeeds, the 767 leading edge slats/flaps were extended (flaps One or Five, as appropriate) in order to stay within minimum safe flying speeds per the 767 Flight Planning and Performance Manual, reference 4.

TEST CRITERIA

13. Handling Qualities Ratings (HQR's) were used to rate the performance and workload associated with positioning and maintaining the receiver aircraft in a steady position behind the 767 aircraft. The pilot HQR's were relative to the pilot's own assessment of acceptability. If Pilot Induced Oscillations (PIO's) were encountered, a PIO rating scale was used. The HQR and PIO rating scales are depicted in appendix D. The pilot's task was to maintain a steady aircraft position of $\pm$5.0 ft (adequate) or $\pm$3.0 ft (desired) at various locations behind the 767 aircraft. Estimated aircraft control input requirements were provided with the HQR's. During all maneuvers in or near the 767 aircraft wake, pilots of the receiver aircraft noted the presence or absence of handling qualities anomalies. Changes in handling qualities while moving from one position to another were also noted. Since in-flight refueling is an inherently work intensive task, HQR's of 3 or better for the F/A-18C and 4 or better for the S-3B were desired. The test point abort criteria was defined with a HQR-7 or when ½ lateral or directional control displacements were required to maintain positioning or when aircraft trim was saturated in any axis. Light air turbulence or less was considered necessary to conduct an accurate evaluation of the 767 wake turbulence.

TEST POINT ACCURACY

14. Actual test points were within ±2,000 ft of target altitude and ±5 KIAS of target airspeed, and did not exceed any NATOPS operating or flight clearance limit.

LIMITATIONS TO SCOPE

15. The test team determined the following limitations to the scope of the Boeing 767 proximity evaluation flight tests:

a. The evaluation was limited to day visual meteorological condition (VMC) operations only.

b. No AR system was installed on the 767-300 aircraft and, therefore, no engagements were performed.

c. The lack of an AR system on the 767 aircraft limited the receiver pilot's ability to quantify accurately the aircraft's position keeping capabilities behind the 767 aircraft.

d. The lack of an AR system on the 767 aircraft also hindered the capability to position the receiver aircraft in the location of the actual air-to-air refueling drogue.

e. The lack of longitudinal references aft of the horizontal tail, coupled with the lack of vertical references hindered the ability to correctly position the receiver aircraft.

f. The limited altitude band evaluated (10,000 - 20,000 ft) only served to "spot check" a small portion of the allowable NATOPS AR altitude envelope, but was consistent with the objectives of a proximity wake turbulence evaluation. The entire envelope will be evaluated in subsequent test phases.

g. The evaluation was conducted during mild turbulence conditions only in order to clearly determine tanker turbulence effects on receiver handling qualities.

METHOD OF TESTS

TEST METHODS AND PROCEDURES

General

16. Flight test matrices for the S-3B and F/A-18C are presented in tables C-1 and C-2, respectively. The detailed method of test is outlined in appendix B. Each receiver aircraft was evaluated behind the 767 aircraft individually to ease in-flight coordination and enhance test safety. A cinematography (photo) aircraft was provided by CLA, as contracted by Boeing. The positioning of this aircraft during testing is described in appendix B.

Specific Tests

17. The series of tests performed at various positions behind the 767 aircraft are fully described in appendix B, and were performed to evaluate the wake turbulence in trail of the 767 airplane. These tests included both rendezvous and proximity tests. Standard rendezvous procedures were used and briefed. Following the rendezvous, the receiver was cleared to move to the right or left observation position, which was a minimum of one receiver aircraft wing span outboard and slightly behind the 767 aircraft wingtip. Proximity tests were performed behind the proposed AR locations aft of the 767 centerline and wingtip pod location(s). The positions evaluated included the precontact position (100 ft aft), the fuel transfer zone (FTZ) (75 ft aft), and the nonfuel transfer zone (NFTZ) (50 ft aft). The receiver aircraft performed a "box evaluation" at each of these positions. The "box" is fully described in appendix B. Station keeping with respect to each test position was aided by the 767 wing and fuselage markings with position calls from the cinematography airplane if requested by the 767 or receiver aircraft.

CHRONOLOGY

18. The following is the order of events during the Boeing 767 Proximity Evaluation with the F/A-18C and S-3B aircraft:

a.	Boeing 767 Proximity Evaluation test plan approved	21 June 2000
b.	Flight No. 1 with lightweight 767	22 June 2000
c.	Flight Nos. 2 and 3 with heavyweight 767	23 June 2000

PERSONNEL ASSIGNMENTS

19. Table 5 lists the primary personnel assigned to the Boeing 767 proximity evaluation test program.

Table 5: Personnel Assignments

Name	Function	Code
Maj. S. Whitley	F/A-18 Project Officer	5.5
LCDR M. Guidry	S-3B Project Officer	5.5
Mr. Brian Markowich	Team Lead/Alt. Test Conductor	4.11.5.2
Mr. Doug Wilkin	Lead Project Engineer/Test Conductor (S-3 and F/A-18)	4.11.1.1
Mr. Dave Stefanic	F/A-18 Platform Coordinator	5.5
LCDR Sean Brennan	S-3 Platform Coordinator	5.5
Mrs. Pam Jones	Photographic Imaging Services Office	7.2
Mr. Randy Dixon	Force Scheduling (S-3/767/Lear 35)	Veridian
Shirley Beckler	Security Office	7.4.1
Mrs. Nancy Neal	Patuxent River Business Development Team	4.0T
Mr. Chuck Harley	Boeing Test Director	Y7WF0
Mr. Jim Ledford	Boeing Test Conductor/Liaison	Y7WF0
Capt. Doug Brown	British Airways PIC/Liaison	---------
Ms. Tina Regina	Clay Lacy Aviation Liaison	---------

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RESULTS AND EVALUATION

S-3B EVALUATION OF 767 WAKE TURBULENCE

GENERAL

20. The S-3B wake turbulence assessment in trail of the 767 was conducted at the 767 centerline and wingtip positions. 767 test GW's ranged from 210,000-340,000 lb, light to heavy GW's. S-3B test GW's ranged from 36,700 – 46,000 lb, light to medium GW's. The positions evaluated ranged from the precontact position (100 ft aft of the aircraft with 40 ft of step down) to the NFTZ (50 ft aft of the aircraft with 20 ft of step down). Test airspeeds were 180, 230, 265, and 270 KIAS. Test altitudes were 10,000 and 20,000 ft MSL. A detailed description of visual cues and the method of test are provided in appendix B. A detailed matrix of each S-3B test point and the wake turbulence assessment made at each point is provided in appendix C. Within the areas and conditions tested, an area of acceptable flying qualities exists in trail of the 767 centerline and wing positions in order for the S-3B to perform the AR mission. Recommend conducting a full wake survey throughout the 767 operational envelope, if the 767 is adopted as a tanker platform, during full tanker qualification testing.

SPECIFIC

21. The 767 turbulence effects on the receiver aircraft came primarily from engine exhaust. The majority of all test areas were assigned HQR's of 2-3 with no noticeable adverse effects on flying qualities. The centerline position afforded the best assessment with HQR 2-3 assigned. Very light airframe buffet was observed and minimal lateral stick inputs or trim were required to maintain position (constant 1 in. stick inputs or ½-1 deg wing down, respectively). Wake turbulence slightly increased at wing test points. HQR's of 4 were assigned for the right wing precontact, fuel transfer, and nonfuel transfer positions when offset left 11 ft. HQR's of 4 were also assigned at the left wing fuel transfer and nonfuel transfer positions when offset right 11 ft. At these positions airframe buffet from engine exhaust noticeably increased and made position keeping more difficult. In these positions lateral stick inputs of up to 2 in./sec were required to offset a tendency to roll inboard toward the 767 and power increases were required to offset a downward vector. The left wing nonfuel transfer position was not tested at 20,000 ft MSL due to heavy airframe buffet at the previous point (HQR 4). There was no noticeable differences in position keeping aft of the light tanker or heavy tanker. Within the areas and conditions tested, an area of acceptable flying qualities existed in trail of the 767 centerline and wingtip positions in order for the S-3B to perform the AR mission. Recommend designing a hose trail position defined by HQR 3 task ratings.

F/A-18 EVALUATION OF 767 WAKE TURBULENCE

GENERAL

22. The F/A-18 wake turbulence assessment in trail of the 767 was conducted at the 767 centerline and wingtip positions. The 767 test GW's ranged from 210,000-340,000 lb, light to heavy GW's. F/A-18 test GW's ranged from 32,800 – 45,000 lb, light to medium GW's. The positions evaluated ranged from the precontact position (100 ft aft of the aircraft with 40 ft of step down) to the NFTZ (50 ft aft of the aircraft with 20 ft of step down). Test airspeeds were 220, 270, and 325 KIAS. Test altitude was 20,000 ft MSL. A detailed description of visual cues and the method of test are provided in appendix B. A detailed matrix of each F/A-18 test point and the wake turbulence assessment made at each point is provided in appendix C. Within the areas and conditions tested, acceptable flying qualities existed in trail of the 767 in order for the F/A-18 to perform the AR mission. Recommend conducting a full wake survey throughout the 767 operational envelope, if the 767 is adopted as a tanker platform, during full tanker qualification testing.

SPECIFIC

23. The 767 turbulence effects on the receiver aircraft came primarily from engine exhaust; however, minor effects from the wingtip vortices were also noted. The majority of all test areas were assigned HQR's of 2 with no noticeable adverse effects on flying qualities. The centerline position afforded the best assessment with HQR's of 2 and 3 assigned. Very light airframe buffet was observed at the upper corners of the centerline wake survey box and minimal lateral trim inputs were required to maintain position (1-2 clicks lateral trim). Wake turbulence slightly increased at wing test points. HQR's of 3 were assigned for the right fuel transfer and nonfuel transfer positions when offset left 11 ft with 10 ft of step up. At these positions, airframe buffet from engine exhaust noticeably increased and made position keeping more difficult. HQR's of 3 were also assigned at the right wing fuel transfer and nonfuel transfer positions when offset right 11 ft and stepped up 10 ft. At these positions, the wingtip vortex required minor inputs to counter a rolling moment away from the 767. Within the areas and conditions tested, acceptable flying qualities existed in trail of the 767 centerline and wing positions in order for the F/A-18 to perform the AR mission.

767 WING DIHEDRAL

24. The wing dihedral of the 767 in all configurations was substantial. The wing dihedral further increased with the 767 in the "heavy" configuration. Substantial was defined as approximately twice that of currently fielded strategic tanker platforms (KC-135, KC-10, and 707). Although the 767 evaluation was conducted in daylight VMC conditions, during normal tanking operations, the sensory ambiguity between the HUD simulated horizon, the "seat of the pants", and the false horizon of the dihedral could cause mild disorientation and vertigo. This phenomenon has been experienced and briefed during previous test programs to increase the receiver aircrew's awareness. The substantial wing dihedral of the 767 may cause a false sense of horizon to receiver aircrew causing minor disorientation and vertigo in conditions with no

defined horizon. Recommend that if the 767 platform is adopted as a tanker platform, the 767 wing dihedral be evaluated during the full in-flight refueling qualification evaluation.

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CONCLUSIONS

GENERAL

25. Within the areas and conditions tested, acceptable flying qualities existed in trail of the 767 centerline and wing positions in order for the S-3B and F/A-18C to perform the AR mission (paragraphs 20 and 22).

SPECIFIC

26. Within the areas and conditions tested, an area of acceptable flying qualities existed in trail of the 767 centerline and wingtip positions in order for the S-3B to perform the AR mission (paragraph 21).

27. Within the areas and conditions tested, acceptable flying qualities existed in trail of the 767 centerline and wing positions in order for the F/A-18 to perform the AR mission (paragraph 23).

28. The substantial wing dihedral of the 767 may cause a false sense of horizon to receiver aircrew causing minor disorientation and vertigo in conditions with no defined horizon (paragraph 24).

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RECOMMENDATIONS

GENERAL

29. Recommend conducting a full wake survey throughout the 767 operational envelope, if the 767 is adopted as a tanker platform, during full tanker qualification testing.

SPECIFIC

30. Conduct a full wake survey throughout the 767 operational envelope if the 767 is adopted as a tanker platform during full tanker qualification testing (paragraphs 20 and 22).

31. Design a hose trail position defined by HQR 3 task ratings (paragraph 21).

32. If the 767 platform is adopted as a tanker platform, evaluate the 767 wing dihedral during the full in-flight refueling qualification evaluation (paragraph 24).

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REFERENCES

1. Commercial Service Agreement NAWCAD-CSA-4K5-0011 between the Boeing Company and NAWCAD Patuxent River, effective 18 May 2000.

2. NATOPS Flight Manual, Navy Model F/A-18A/B/C/D 161353 and Up Aircraft, A1 F18AC-NFM-000, of 15 Jan 1997, with Change 5 of 1 Sep 1999.

3. NATOPS Flight Manual, Navy Model S-3B Aircraft, NAVAIR 01-S3AAB-1, of 1 Oct 1993, with Change 2 of 1 Nov 1997.

4. Boeing Flight Planning and Performance Manual (Performance Data for 767-300 w/RB211-524H), Boeing Document No. D632T003-VV692, of 8 Oct 1999.

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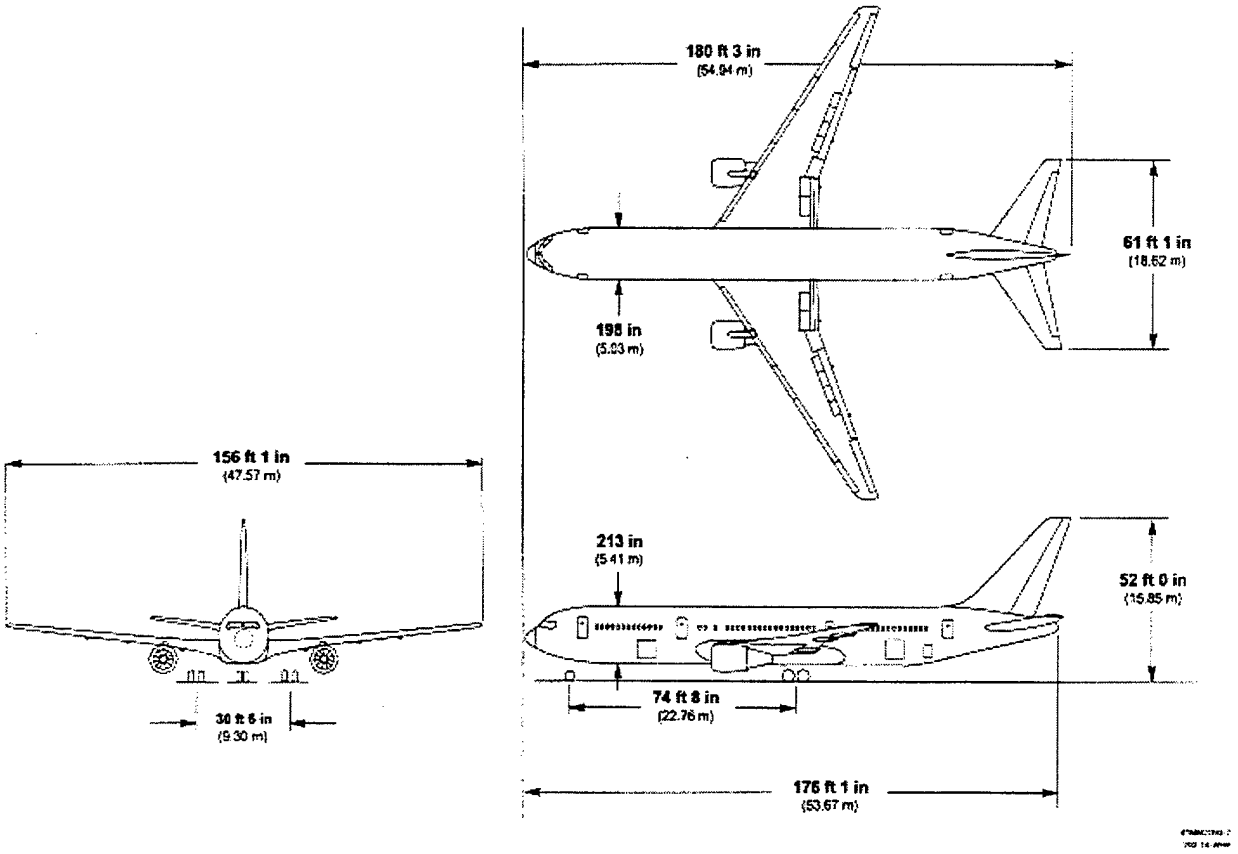
APPENDIX A
BOEING 767-300ER AIRCRAFT DIMENSIONS AND TEST MARKINGS



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APPENDIX B
DETAILED METHOD OF TESTS

1. The F/A-18 and S-3B receiver aircraft established a baseline of flying qualities out of the 767 influence during the rendezvous. Standard rendezvous procedures were used and briefed. Following the rendezvous, the receiver was cleared to move to the right or left observation position, which was a minimum one tanker aircraft wing span outboard and slightly behind the 767 aircraft wingtip. Prior to moving to the precontact position, the receiver pilot ensured that the "air refueling before plug-in" or "aerial refueling" checklist was completed as appropriate. Proximity tests were performed while aft of the 767 centerline and at proposed AR pod locations at each wingtip. The positions evaluated included the precontact position (100 ft aft, 40 ft step down), the FTZ (75 ft aft, 30 ft step down) and the NFTZ (50 ft aft, 20 ft step down). The receiver aircraft performed a "box evaluation" as shown in figure B-1, at each of these positions. Pilots assessed their ability, via HQR's, to maintain a steady aircraft position of $\pm$5.0 ft (adequate) or $\pm$3.0 ft (desired) at each point in the "box". The "edges" of the box were defined when HQR 7 was reached or when ½ lateral or directional control displacements was required to maintain position or if aircraft trim was saturated in any axis. Station keeping with respect to all test positions was aided by the 767 wing and fuselage markings and position calls from the cinematography airplane, as requested by the 767 or receiver aircraft. The following data were recorded on kneeboard cards, voice recorders or via photographers in the 767 or Lear 35 photo chase aircraft, as applicable:

a. Indicated airspeed, altitude, and GW for receiver and the 767 aircraft.

b. 767 aircrew assessment of air turbulence.

c. Receiver HQR and qualitative comments.

d. Receiver aircraft aileron, rudder, and pitch trim (as applicable) and the amount/direction of control inputs (i.e., half RT stick, full LT rudder) and power requirements.

e. Time indexed cinematography video or film documentation.

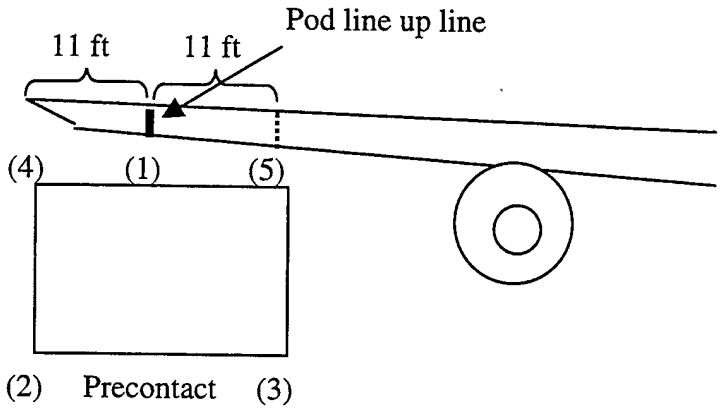

Figure B-1: Wake Box
(left wingtip shown, right wing is mirror image)

2. Specific Test Procedures. Testing with each receiver aircraft initially was performed with the 767 aircraft in the light GW range (53-65% maximum GW) followed by tests in the heavy GW range (70-85% maximum GW). Receiver aircraft GW were not used as buildup; however, testing was begun with the receiver aircraft at heavy GW's with a burn down to the lighter weights. The test procedures, identified below, were identical throughout the speed, altitude, and GW ranges; however, the capability of the 767 and receiver aircraft dictated the actual flight conditions flown.

a. Rendezvous Procedure: Standard rendezvous procedures were used and briefed. Following the rendezvous, the receiver was cleared to move to the left or right observation position, with a minimum one receiver aircraft wing span outboard of and slightly behind the 767 wingtip.

b. Centerline Precontact Position: Proximity testing for a given airspeed/altitude condition began at the centerline position. From the left or right observation position, the receiver aircraft was cleared into the centerline precontact position (100 ft aft of the rear of the aircraft with 40 ft of step down). Once established, the receiver aircraft performed the box evaluation as described below:

(1) Climbed 30 ft (10 ft of step down) and then returned to the precontact position.

(2) Moved 10 ft to the left of the 767 centerline and then returned to the precontact position.

(3) Moved 10 ft to the right of the 767 centerline and then returned to the precontact position.

(4) Moved 10 ft to the left of the 767 centerline, climbed 30 ft, stabilized, descended 30 ft, then returned to the precontact position.

(5) Moved 10 ft to the right of the 767 centerline, climbed 30 ft, stabilized, descended 30 ft, then returned to the precontact position.

(6) A rectangular pattern was flown by moving 10 ft to the left, climbing 30 ft (10 ft of step-down) stabilizing, moving right 10 ft, stabilizing, moving right an additional 10 ft, stabilizing, descending 30 ft, returning to the precontact position by moving laterally 10 ft to the left.

c. Centerline Fuel Transfer Zone: For testing at the centerline FTZ, the receiver aircraft was positioned 75 ft aft of the rear of the 767 aircraft (on centerline) with 30 ft of step-down. Once established in the FTZ, the receiver aircraft performed the box evaluation as described below:

(1) Climbed 20 ft (10 ft of step down) and then returned to the FTZ.

(2) Moved 10 ft to the left of the 767 centerline and then returned to the FTZ.

(3) Moved 10 ft to the right of the 767 centerline and then returned to the FTZ.

(4) Moved 10 ft to the left of the 767 centerline, climbed 20 ft, stabilized, descended 20 ft, then returned to the FTZ.

(5) Moved 10 ft to the right of the 767 centerline, climbed 20 ft, stabilized, descended 20 ft, then returned to the FTZ.

(6) A rectangular pattern was flown by moving 10 ft to the left, climbing 20 ft (10 ft of step-down) stabilizing, moving right 10 ft, stabilizing, moving right an additional 10 ft, stabilizing, descending 20 ft, returning to the FTZ by moving laterally 10 ft to the left.

d. Centerline Nonfuel Transfer Zone: For testing at the centerline NFTZ, the receiver aircraft was positioned 50 ft aft of the rear of the 767 aircraft (on centerline) with 20 ft of step-down. Once established in the centerline NFTZ, the receiver aircraft performed the box evaluation as described below:

(1) Climbed 10 ft (10 ft of step down) and then returned to the NFTZ.

(2) Moved 10 ft to the left of the 767 centerline and then returned to the NFTZ.

(3) Moved 10 ft to the right of the 767 centerline and then returned to the NFTZ.

(4) Moved 10 ft to the left of the 767 centerline, climbed 10 ft, stabilized, descended 10 ft, then returned to the NFTZ.

(5) Moved 10 ft to the right of the 767 centerline, climbed 10 ft, stabilized, descended 10 ft, then returned to the NFTZ.

(6) A rectangular pattern was flown by moving 10 ft to the left, climbing 10 ft, stabilizing, moving right 10 ft, stabilizing, moving right an additional 10 ft, stabilizing, descending 10 ft, returning to the NFTZ by moving laterally 10 ft to the left.

e. Right Wing Precontact Position: Once proximity tests were completed at the centerline position, testing was performed at the simulated engagement area aft of the 767 right wingtip. The receiver aircraft was cleared to move into the precontact position for the right wing. The precontact position for the right wing was defined as 100 ft aft of the 767 wing trailing edge in line with the right pod line up line with 40 ft of step-down. Once established in the precontact position, the receiver aircraft performed the box evaluation as described below:

(1) Climbed 30 ft (10 ft below the wing of the 767) and then returned to the precontact position.

(2) Moved 11 ft to the right of the right wing precontact position (*this lined the receiver aircraft with right wingtip*) and return to the precontact position.

(3) Moved 11 ft to the left (*this lined the receiver aircraft up with the inboard limit marking on the right wing*) and then returned to the precontact position.

(4) Moved 11 ft to the right of the precontact position, climbed 30 ft, stabilized, descended 30 ft, returned to the precontact position.

(5) Moved 11 ft to the left of the precontact position, climbed 30 ft, stabilized, descended 30 ft, then returned to the precontact position.

(6) A rectangular pattern was flown by moving 11 ft to the right, climbing 30 ft, stabilizing, moving left 11 ft, stabilizing, moving left an additional 11 ft, stabilizing, descending 30 ft, returning to the precontact position by moving 11 ft to the right.

f. Right Wing Fuel Transfer Zone: For testing at the right wing FTZ, the receiver aircraft was positioned 75 ft aft of the 767 wing trailing edge in line with the right pod line-up line with 30 ft of step-down. Once established in the FTZ, the receiver aircraft performed the box evaluation as described below:

(1) Climbed 20 ft and then returned to the FTZ.

(2) Moved 11 ft to the right and then returned to the FTZ.

(3) Moved 11 ft to the left and then returned to the FTZ.

(4) Moved 11 ft to the right, climbed 20 ft, stabilized, descended 20 ft, returned to the FTZ.

(5) Moved 11 ft to the left, climbed 20 ft, stabilized, descended 20 ft, returned to the FTZ.

(6) A rectangular pattern was flown by moving 11 ft to the right, climbing 20 ft, stabilize, moving left 11 ft, stabilizing, moving left an additional 11 ft, stabilizing, descending 20 ft, returning to the FTZ by moving 11 ft to the right.

g. Right Nonfuel Transfer Zone: The right wing NFTZ was defined as 50 ft aft of the 767 wing trailing edge in line with the right pod line up line with 20 ft of step-down. Once established in the NFTZ, the receiver aircraft performed the box evaluation as described below:

(1) Climbed 10 ft and then returned to the NFTZ.

(2) Moved 11 ft to the right and returned to the NFTZ.

(3) Moved 11 ft to the left and then returned to the NFTZ.

(4) Moved 11 ft to the right, climbed 10 ft, stabilized, descended 10 ft, returned to the NFTZ.

(5) Moved 11 ft to the left, climbed 10 ft, stabilized, descended 10 ft, returned to the NFTZ.

(6) A rectangular pattern was flown by moving 11 ft to the right, climbing 10 ft, stabilizing, moving left 11 ft, stabilizing, moving left an additional 11 ft, stabilizing, descending 10 ft, returning to the NFTZ by moving 11 ft to the right.

h. Left Wing Precontact Position: Once the right wing positions were completed, the receiver was cleared to move into the precontact position for the left wing. The precontact position for the left wing was defined as 100 ft aft of the 767 wing trailing edge in line with the left pod line up line with 40 ft of step-down. Once established in the precontact position, the receiver aircraft performed the box evaluation as described below:

(1) Climbed 30 ft (10 ft below the wing of the 767) and then returned to the precontact position.

(2) Moved 11 ft to the left (*this lined the receiver aircraft up with the left wingtip*) and then returned to the precontact position.

(3) Moved 11 ft to the right of the left wing precontact position (*this lined the receiver aircraft with the inboard limit marking on the left wing*) and returned to the precontact position.

(4) Moved 11 ft to the left of the precontact position, climbed 30 ft, stabilized, descended 30 ft, then returned to the precontact position.

(5) Moved 11 ft to the right of the precontact position, climbed 30 ft, stabilized, descended 30 ft, returned to the precontact position.

(6) A rectangular pattern was flown by moving 11 ft to the left, climbing 30 ft, stabilizing, moving right 11 ft, stabilizing, moving right an additional 11 ft, stabilizing, descending 30 ft, returning to the precontact position by moving 11 ft to the left.

i. Left Wing Fuel Transfer Zone: For testing at the left wing FTZ, the receiver aircraft was positioned 75 ft aft of the 767 wing trailing edge in line with the left pod line-up line with 30 ft of step-down. Once established in the FTZ, the receiver aircraft performed the box evaluation as described below:

(1) Climbed 20 ft and then returned to the FTZ.

(2) Moved 11 ft to the left and then returned to the FTZ.

(3) Moved 11 ft to the right and then returned to the FTZ.

(4) Moved 11 ft to the left, climbed 20 ft, stabilized, descended 20 ft, returned to the FTZ.

(5) Moved 11 ft to the right, climbed 20 ft, stabilized, descended 20 ft, returned to the FTZ.

(6) A rectangular pattern was flown by moving 11 ft to the left, climbing 20 ft, stabilizing, moving right 11 ft, stabilizing, moving right an additional 11 ft, stabilizing, descending 20 ft, returning to the FTZ by moving 11 ft to the left.

j. Left Nonfuel Transfer Zone: The left wing NFTZ was defined as 50 ft aft of the 767 wing trailing edge in line with the left pod line up line with 20 ft of step-down. Once established in the NFTZ, the receiver aircraft performed the box evaluation as described below:

(1) Climbed 10 ft and then returned to the NFTZ.

(2) Moved 11 ft to the left and then returned to the NFTZ.

(3) Moved 11 ft to the right and returned to the NFTZ.

(4) Moved 11 ft to the left, climbed 10 ft, stabilized, descended 10 ft, returned to the NFTZ.

(5) Moved 11 ft to the right, climbed 10 ft, stabilized, descended 10 ft, returned to the NFTZ.

(6) A rectangular pattern was flown by moving 11 ft to the left, climb 10 ft, stabilizing, moving right 11 ft, stabilizing, moving right an additional 11 ft, stabilizing, descending 10 ft, returning to the NFTZ by moving 11 ft to the left.

3. Buildup Approach. Testing was conducted using buildup in 767 GW, test airspeed, location behind the 767, and distance behind the 767. Testing at light 767 GW was conducted first at all airspeeds, altitudes, and locations. Receiver locations aft of the 767 centerline and right wing were evaluated at the mid-envelope airspeed test point first, followed by the lower or higher airspeed test points if present. Testing behind the left 767 wingtip was only performed as an occasional spot check of the right side. Centerline tests were performed prior to the wing station tests for the given test airspeed/altitude/767 GW condition. At each receiver location behind the 767, the proximity checks were performed at successively closer positions to the 767 aircraft beginning with the precontact position (100 ft aft), then the FTZ (75 ft aft), and finally the NFTZ (50 ft aft). The receiver aircraft GW was not used for buildup. Altitude was not considered critical for buildup either; and, the 20,000 ft test points were conducted with the F/A-18. S-3B aircraft handling qualities are more favorable at the lower altitudes, so that receiver began tests at 10,000 ft.

4. Cinematography Aircraft Position. The Lear 35 was clear of the receiver/tanker formation (stacked a minimum of 2,000 ft vertical separation from the 767 aircraft) until the receiver had completed the rendezvous. Once the receiver had been cleared to the centerline precontact position, the Lear 35 was cleared to the photo chase position. At this position there was at least one tanker wingspan (~160 ft) clearance between the tanker and the Lear 35's wingtips. Once the receiver was cleared to the centerline precontact position, the Lear 35 moved longitudinally and vertically as required to facilitate photo documentation and to aid in position keeping estimates for the receiver. Once all proximity tests were completed at the centerline position, the 767 aircraft instructed the receiver to move to the right wing precontact position. When these test points were completed, the 767 cleared the receiver aircraft to the left wing Precontact position. The Lear 35 was positioned at the left or right photo chase position (minimum of 160 ft outboard of the 767 aircraft outboard wingtip) during the proximity tests. Once cleared by the 767 aircraft, the Lear 35 moved to the opposite wing photo chase position by moving aft of and below the tanker/receiver formation and then by moving across the tanker/receiver formation. Once at the photo chase position, the Lear 35 maneuvered longitudinally and vertically as required to facilitate photo documentation and position keeping estimates for the receiver. Once all test positions were completed for a given airspeed/altitude, the 767 aircraft instructed the Lear 35 to depart the formation. The Lear 35 assumed at least a 2,000 ft vertical separation from the tanker/receiver. The 767 aircraft then moved the receiver to the left reform area. Once the

receiver was established at the left reform area, the 767 aircraft cleared the receiver to depart the formation. The receiver departed and affected a rendezvous once the tanker had established the next airspeed/altitude test condition or return to base.

APPENDIX C
S-3B AND F/A-18C TEST POINT MATRICES

LIGHT GROSS WEIGHT 767 PROXIMITY WITH S-3B TEST POINT MATRIX FLIGHT 1

Point No.	Base Position	Position Deviation	Airspeed (KIAS)	Altitude (ft MSL)	Receiver Fuel Weight (K lb)	HQR	PIO	Receiver Pilot Comments
1	Centerline Precontact[1]	None	230	10,000	12.4	2	1	Trim neutral
1.a		30 ft up				3	1	Very light airframe buffet from engine plumes.
1.b		10 ft left				2	1	
1.c		10 ft right				2	1	
1.d		10 ft left and 30 ft up				3	1	Very light airframe buffet from engine plume.
1.e		10 ft right and 30 ft up				3	1	Very light airframe buffet from engine plume.
1.f		Rectangle Pattern (CW)				3	1	Minimal lateral stick inputs (1 in. right) were required across the top of the box.
2	Centerline FTZ[2]	None	230	10,000	11.9	2	1	Trim neutral.
2.a		20 ft up				2	1	
2.b		10 ft left				3	1	½ deg left wing down trim.
2.c		10 ft right				3	1	½ deg right wing down trim.
2.d		10 ft left and 20 ft up				3	1	1 deg left wing down trim. Very light airframe buffet from engine plume.
2.e		10 ft right and 20 ft up				3	1	Very light airframe buffet from engine plume.
2.f		Rectangle Pattern (CW)				3	1	Minimal lateral stick inputs (1 in. right) were required across the top of the box.
3	Centerline NFTZ[3]	None	230	10,000	11.6	2	1	Trim neutral.
3.a		10 ft up				2	1	
3.b		10 ft left				2	1	
3.c		10 ft right				2	1	
3.d		10 ft left and 10 ft up				2	1	Very light airframe buffet from engine plume.
3.e		10 ft right and 10 ft up				2	1	½ deg right wing down trim. Very light airframe buffet from engine plume.
3.f		Rectangle Pattern (CW)				2	1	Minimal lateral stick inputs (1 in. right) were required across the top of the box.

S-3B Flight 1 (Cont'd)

Point No.	Base Position	Position Deviation	Airspeed (KIAS)	Altitude (ft MSL)	Receiver Fuel Weight (K lb)	HQR	PIO	Receiver Pilot Comments
4	Right Wing Precontact[1]	None	230	10,000	11.0	2	1	Trim 6 deg right wing down 2 deg right rudder.
4.a		30 ft up				3	1	Very light airframe buffet from engine plume.
4.b		11 ft right				2	1	
4.c		11 ft left				4	1	Mild airframe buffet from engine plume. Lateral stick inputs of up to 2 in./sec (right) were required. Power increase of 6% required.
4.d		11 ft right and 30 ft up				2	1	
4.e		11 ft left and 30 ft up				4	1	Moderate airframe buffet from engine plume. Same inputs as 4.c.
4.f		Rectangle Pattern (CCW)				4	1	Airflow in upper left corner pulled aircraft in and down.
5	Right Wing FTZ[2]	None	230	10,000	10.9	2	1	Trim 7 deg right wing down 2 deg right rudder.
5.a		20 ft up				3	1	Very light airframe buffet from engine plume.
5.b		11 ft right				2	1	
5.c		11 ft left				2	1	
5.d		11 ft right and 20 ft up				2	1	
5.e		11 ft left and 20 ft up				3	1	Mild airframe buffet from engine plume.
5.f		Rectangle Pattern (CCW)				3	1	Mild airframe buffet from engine plume at point 5.e. Power increase of 4% required.
6	Right Wing NFTZ[3]	None	230	10,000	10.8	3	1	Trim 7 deg right wing down 4 deg right rudder.
6.a		10 ft up				3	1	Minimal lateral stick inputs (1 in. right) were required.
6.b		10 ft right				2	1	
6.c		10 ft left				2	1	
6.d		10 ft right and 10 ft up				2	1	

S-3B Flight 1 (Cont'd)

Point No.	Base Position	Position Deviation	Airspeed (KIAS)	Altitude (ft MSL)	Receiver Fuel Weight (K lb)	HQR	PIO	Receiver Pilot Comments
6.e	Right Wing NFTZ[3]	10 ft left and 10 ft up	230	10,000	10.8	3	1	Mild airframe buffet from engine plume. Minimal lateral stick inputs (1 in. right) were required.
6.f		Rectangle Pattern (CCW)				4	1	Airflow in upper left corner pulled aircraft in and down. Same buffet and input as 6.e. Power increase of 4% required.
7	Left Wing Precontact[1]	None	230	10,000	10.4	2	1	Trim 3 deg left wing down neutral rudder.
7.a		30 ft up				2	1	
7.b		11 ft left				2	1	
7.c		11 ft right				2	1	
7.d		11 ft left and 30 ft up				2	1	
7.e		11 ft right and 30 ft up				3	1	Very light airframe buffet from engine plume. Increased trim to 3.5 deg left wing down.
7.f		Rectangle Pattern (CW)				3	1	Mild airframe buffet from engine plume. Minimal lateral stick inputs (1 in. left) were required across the top of the box. Airflow pulling inward.
8	Left Wing FTZ[2]	None	230	10,000	10.4	3	1	Trim 3.5 deg left wing down neutral rudder. Minimal lateral stick inputs (1 in. left) were required.
8.a		20 ft up				2	1	
8.b		11 ft left				2	1	
8.c		11 ft right				2	1	
8.d		11 ft left and 20 ft up				2	1	Trim 4.5 deg left wing down.
8.e		11 ft right and 20 ft up				3	1	Mild airframe buffet from engine plume. Minimal lateral stick inputs (1 in. left) were required.
8.f		Rectangle Pattern (CW)				3	1	Airflow pulling in and down across the top of the box. Minimal lateral stick inputs (1 in. left) required.

S-3B Flight 1 (Cont'd)

Point No.	Base Position	Position Deviation	Airspeed (KIAS)	Altitude (ft MSL)	Receiver Fuel Weight (K lb)	HQR	PIO	Receiver Pilot Comments
9	Left Wing NFTZ[3]	None	230	10,000	10.3	2	1	Trim 5 deg left wing down 0.5 left rudder (light turbulence in the area).
9.a		10 ft up				3	1	Minimal lateral stick inputs (1 in. left) required.
9.b		11 ft left				2	1	
9.c		11 ft right				2	1	
9.d		11 ft left and 10 ft up				3	1	Minimal lateral stick inputs (1 in. left) required.
9.e		11 ft right and 10 ft up				4	1	Moderate airframe buffet from engine plume. Lateral stick inputs of up to 2 in./sec (left) were required.
9.f		Rectangle Pattern (CW)				3	1	Lateral stick inputs (left) increased across top of the box. Power decrease of 4% required. Airflow pulling in and down.
10	Centerline Precontact[1]	None	270	10,000	9.8	2	1	Trim neutral.
10.a		30 ft up				2	1	
10.b		10 ft left				2	1	
10.c		10 ft right				2	1	
10.d		10 ft left and 30 ft up				2	1	
10.e		10 ft right and 30 ft up				2	1	Trim 1 deg right wing down.
10.f		Rectangle Pattern (CW)				2	1	
11	Centerline FTZ[2]	None	270	10,000	9.6	2	1	Trim neutral.
11.a		20 ft up				2	1	
11.b		10 ft left				2	1	
11.c		10 ft right				2	1	
11.d		10 ft left and 20 ft up				2	1	
11.e		10 ft right and 20 ft up				2	1	Very light airframe buffet from engine plume.
11.f		Rectangle Pattern (CW)				2	1	On right side of the box 1 deg of right wing down required.
12	Centerline NFTZ[3]	None	270	10,000	9.5	2	1	
12.a		10 ft up				2	1	
12.b		10 ft left				2	1	

S-3B Flight 1 (Cont'd)

Point No.	Base Position	Position Deviation	Airspeed (KIAS)	Altitude (ft MSL)	Receiver Fuel Weight (K lb)	HQR	PIO	Receiver Pilot Comments
12.c		10 ft right				2	1	
12.d		10 ft left and 10 ft up				2	1	
12.e	Centerline NFTZ[3]	10 ft right and 10 ft up	270	10,000	9.5	2	1	
12.f		Rectangle Pattern (CW)				2	1	
13	Right Wing Precontact[1]	None	270	10,000	9.2	2	1	Trim 6 deg right wing down 2 deg right rudder.
13.a		30 ft up				3	1	Very light airframe buffet from engine plume.
13.b		11 ft right				2	1	
13.c		11 ft left				2	1	
13.d		11 ft right and 30 ft up				2	1	
13.e		11 ft left and 30 ft up				2	1	
13.f		Rectangle Pattern (CCW)				2	1	Very light airframe buffet from engine plume across top of box.
14	Right Wing FTZ[2]	None	270	10,000	9.1	2	1	Trim 6 deg right wing down 2 deg right rudder (light turbulence in the area).
14.a		10 ft up				2	1	
14.b		11 ft right				2	1	
14.c		11 ft left				2	1	
14.d		11 ft right and 10 ft up				2	1	Trim 7 deg right wing down.
14.e		11 ft left and 10 ft up				2	1	Mild airframe buffet from engine plume.
14.f		Rectangle Pattern (CCW)				2	1	
15	Right Wing NFTZ[3]	None	270	10,000	9.0	2	2	Trim 7 deg right wing down 1 deg right rudder.
15.a		10 ft up				2	1	Holding lateral stick input (1 in. right) required.
15.b		10 ft right				2	1	
15.c		10 ft left				2	1	
15.d		10 ft right and 10 ft up				2	1	
15.e		10 ft left and 10 ft up				2	1	Very light airframe buffet from engine plume.

S-3B Flight 1 (Cont'd)

Point No.	Base Position	Position Deviation	Airspeed (KIAS)	Altitude (ft MSL)	Receiver Fuel Weight (K lb)	HQR	PIO	Receiver Pilot Comments
15.f	Right Wing NFTZ[3]	Rectangle Pattern (CCW)	270	10,000	9.0	3	1	Airflow in upper left corner pulled aircraft in and down. Same buffet and input as 15.e. Holding lateral stick input (1 in.) plus (1 in.) inputs to cross the top of the box.
22	Centerline Precontact[1]	None	230	10,000	8.6	2	1	Trim neutral.
22.a		30 ft up				2	1	
22.b		10 ft left				2	1	
22.c		10 ft right				2	1	
22.d		10 ft left and 30 ft up				2	1	Trim 1 deg left wing down.
22.e		10 ft right and 30 ft up				2	1	Very light airframe buffet from engine plume. Trim 1 deg right wing down.
22.f		Rectangle Pattern (CW)				2	1	
23	Centerline FTZ[2]	None	230	10,000	8.5	2	1	Trim neutral.
23.a		20 ft up				2	1	Very light airframe buffet from engine plume.
23.b		10 ft left				2	1	
23.c		10 ft right				2	1	
23.d		10 ft left and 20 ft up				2	1	Very light airframe buffet from engine plume.
23.e		10 ft right and 20 ft up				2	1	Trim 1 deg right wing down.
23.f		Rectangle Pattern (CW)				2	1	Very light airframe buffet from engine plumes across top of the box.
24	Centerline NFTZ[3]	None	230	10,000	8.3	2	1	Trim neutral.
24.a		10 ft up				2	1	
24.b		10 ft left				2	1	
24.c		10 ft right				2	1	
24.d		10 ft left and 10 ft up				2	1	Very light airframe buffet from engine plume.
24.e		10 ft right and 10 ft up				2	1	Very light airframe buffet from engine plume.
24.f		Rectangle Pattern (CW)				2	1	Very light airframe buffet from engine plume across the top of the box.

S-3B Flight 1 (Cont'd)

Point No.	Base Position	Position Deviation	Airspeed (KIAS)	Altitude (ft MSL)	Receiver Fuel Weight (K lb)	HQR	PIO	Receiver Pilot Comments
25	Right Wing Precontact[1]	None	230	10,000	7.9	2	1	Trim 7 deg right wing down 2 deg right rudder.
25.a		30 ft up				2	1	
25.b		11 ft right				2	1	
25.c		11 ft left				2	1	
25.d		11 ft right and 30 ft up				3	1	Holding lateral stick input (1 in. right) required.
25.e		11 ft left and 30 ft up				4	1	Moderate airframe buffet from engine plume. Holding lateral stick input (1 in. right) plus further input (1 in. right) required for station keeping.
25.f		Rectangle Pattern (CCW)				3	1	Moderate airframe buffet from engine plume across the top of the box. Lateral inputs (2 in. right) required.
26	Right Wing FTZ[2]	None	230	10,000	7.8	2	1	Trim 7 deg right wing down 3 deg right rudder.
26.a		20 ft up				2	1	Very light airframe buffet from engine plume.
26.b		11 ft right				3	1	Minimal lateral stick inputs (1 in. right) required.
26.c		11 ft left				2	1	
26.d		11 ft right and 20 ft up				3	1	Minimal lateral stick inputs (1 in. right) required.
26.e		11 ft left and 20 ft up				4	1	Moderate airframe buffet from engine plume. Holding lateral stick input (1 in. right) plus further input (1 in. right) required for station keeping. Airflow pulling in.
26.f		Rectangle Pattern (CCW)				3	1	Moderate airframe buffet from engine plume across the top of the box. Lateral inputs (2 in. right) required.

S-3B Flight 1 (Cont'd)

Point No.	Base Position	Position Deviation	Airspeed (KIAS)	Altitude (ft MSL)	Receiver Fuel Weight (K lb)	HQR	PIO	Receiver Pilot Comments
27	Right Wing NFTZ(3)	None	230	10,000	7.7	3	1	Trim 7 deg right wing down 4 deg right rudder. Holding lateral stick input (1 in. right) required.
27.a		10 ft up				3	1	Holding lateral stick input (1 in. right) plus further input (1 in. right) required for station keeping. Airflow pulling in.
27.b		10 ft right				2	1	
27.c		10 ft left				2	1	
27.d		10 ft right and 10 ft up				2	1	
27.e		10 ft left and 10 ft up				4	1	Moderate airframe buffet from engine plume. Holding lateral stick input (1 in. right) plus further input (1 in. right) required for station keeping. Airflow pulling in.
27.f		Rectangle Pattern (CCW)				3	1	Airflow pulling in and down.

NOTES: (1) Precontact position 100 ft aft and 40 ft below tailcone or wing station of the 767 aircraft, as appropriate. Horizontal position deviation based on pod line up line. Vertical position deviation based on tanker visual cues.

(2) FTZ 75 ft aft and 30 ft below tailcone or wing station of the 767 aircraft, as appropriate.

(3) NFTZ 50 ft aft and 20 ft below tailcone or wing station of the 767 aircraft, as appropriate.

HEAVY GROSS WEIGHT 767 PROXIMITY WITH S-3B TEST POINT MATRIX FLIGHT 2

Point No.	Base Position	Position Deviation	Airspeed (KIAS)	Altitude (ft MSL)	Receiver Fuel Weight (K lb)	HQR	PIO	Receiver Pilot Comments
16	Centerline Precontact[1]	None	230	20,000	11.3	2	1	Trim 1 deg right wing down rudder neutral.
16.a		30 ft up				2	1	Power increase of 8% required.
16.b		10 ft left				2	1	
16.c		10 ft right				2	1	
16.d		10 ft left and 30 ft up				2	1	Power increase of 6% required.
16.e		10 ft right and 30 ft up				2	1	Very light airframe buffet from engine plume.
16.f		Rectangle Pattern (CW)				2	1	
17	Centerline FTZ[2]	None	230	20,000	11.1	2	1	Trim neutral.
17.a		20 ft up				2	1	Power increase of 4% required.
17.b		10 ft left				2	1	
17.c		10 ft right				2	1	
17.d		10 ft left and 20 ft up				2	1	
17.e		10 ft right and 20 ft up				2	1	Very light airframe buffet from engine plume.
17.f		Rectangle Pattern (CW)				2	1	Very light airframe buffet from engine plume across top of the box. Power increase of 4% required.
18	Centerline NFTZ[3]	None	230	20,000	11.0	2	1	Trim neutral.
18.a		10 ft up				2	1	Very light airframe buffet from engine plume.
18.b		10 ft left				2	1	
18.c		10 ft right				2	1	
18.d		10 ft left and 10 ft up				2	1	Very light airframe buffet from engine plume.
18.e		10 ft right and 10 ft up				2	1	Very light airframe buffet from engine plume.
18.f		Rectangle Pattern (CW)				2	1	Very light airframe buffet from engine plume across the top of the box. Power increase of 4% required.

S-3B Flight 2 (Cont'd)

Point No.	Base Position	Position Deviation	Airspeed (KIAS)	Altitude (ft MSL)	Receiver Fuel Weight (K lb)	HQR	PIO	Receiver Pilot Comments
19	Right Wing Precontact[1]	None	230	20,000	10.8	2	1	Trim 7 deg right wing down 3 deg right rudder. Holding lateral stick input (1 in. right) required.
19.a		30 ft up				3	1	Very light airframe buffet from engine plume.
19.b		11 ft right				2	1	
19.c		11 ft left				2	1	
19.d		11 ft right and 30 ft up				2	1	
19.e		11 ft left and 30 ft up				3	1	Moderate airframe buffet from engine plume. Holding lateral stick input (1 in. right) plus further input (1 in. right) required for station keeping.
19.f		Rectangle Pattern (CW)				3	1	Airflow in upper left corner pulled aircraft in and down. Same buffet and input as 19.e. Power increase of 6% required.
20	Right Wing FTZ[2]	None	230	20,000	10.6	2	1	Trim 7 deg right wing down 3 deg right rudder. Holding lateral stick input (1 in. right) required.
20.a		20 ft up				2	1	Very light airframe buffet from engine plume.
20.b		11 ft right				2	1	
20.c		11 ft left				2	1	
20.d		11 ft right and 20 ft up				2	1	Airflow pulling in slightly.
20.e		11 ft left and 20 ft up				3	1	Mild airframe buffet from engine plume. Power increase of 8% required.
20.f		Rectangle Pattern (CW)				3	1	Mild airframe buffet from engine plume at point 20.e. Power increase of 8% required.

S-3B Flight 2 (Cont'd)

Point No.	Base Position	Position Deviation	Airspeed (KIAS)	Altitude (ft MSL)	Receiver Fuel Weight (K lb)	HQR	PIO	Receiver Pilot Comments
21	Right Wing NFTZ[3]	None	230	20,000	10.6	3	1	Trim 7 deg right wing down 3 deg right rudder. Mild airframe buffet from engine plume. Airflow puling in slightly. Minimal lateral stick inputs (1 in. right) were required.
21.a		10 ft up				3	1	Holding lateral stick input (1 in. right) plus further input (1 in. right per sec required for station keeping.
21.b		10 ft right				2	1	
21.c		10 ft left				2	1	Very light airframe buffet from engine plume.
21.d		10 ft right and 10 ft up				2	1	Airflow pulling in slightly.
21.e		10 ft left and 10 ft up				4	1	Moderate airframe buffet from engine plume. Holding lateral stick input (1 in. right) plus further input (1 in. right) required for station keeping. Power increase of 6% required.
21.f		Rectangle Pattern (CW)				3	1	Airflow in upper left corner pulled aircraft in and down. Same buffet and input as 21.e. Power increase of 8% required.
37	Centerline Precontact[1]	None	180	10,000	8.3	2	1	Trim 2.5 deg right wing down rudder neutral.
37.a		30 ft up				2	1	
37.b		10 ft left				2	1	
37.c		10 ft right				2	1	Trim 3 deg right wing down.
37.d		10 ft left and 30 ft up				2	1	Very light airframe buffet from engine plume.
37.e		10 ft right and 30 ft up				2	1	Mild airframe buffet from engine plume.
37.f		Rectangle Pattern (CW)				2	1	Mild airframe buffet from engine plume across the top of the box. Trim 3.5 deg right wing down.

S-3B Flight 2 (Cont'd)

Point No.	Base Position	Position Deviation	Airspeed (KIAS)	Altitude (ft MSL)	Receiver Fuel Weight (K lb)	HQR	PIO	Receiver Pilot Comments
38	Centerline FTZ[2]	None	180	10,000	8.3	2	1	Trim 2 deg right wing down rudder neutral.
38.a		20 ft up				2	1	
38.b		10 ft left				2	1	
38.c		10 ft right				2	1	Trim 2.5 deg right wing down.
38.d		10 ft left and 20 ft up				2	1	Very light airframe buffet from engine plume.
38.e		10 ft right and 20 ft up				2	1	Trim 3 deg right wing down. Very light airframe buffet from engine plume.
38.f		Rectangle Pattern (CW)				2	1	Trim 3.5 deg right wing down. Mild airframe buffet from engine plume across top of the box. Power increase of 4% required.
39	Centerline NFTZ[3]	None	180	10,000	8.1	2	1	Trim 2 deg right wing down rudder neutral.
39.a		10 ft up				2	1	Mild airframe buffet from engine plume. Power increase of 4% required.
39.b		10 ft left				2	1	
39.c		10 ft right				2	1	Trim 3 deg right wing down.
39.d		10 ft left and 10 ft up				2	1	Mild airframe buffet from engine plume.
39.e		10 ft right and 10 ft up				2	1	Trim 6 deg right wing down. Mild airframe buffet from engine plume.
39.f		Rectangle Pattern (CW)				2	1	Trim 7 deg right wing down. Mild airframe buffet from engine plume across the top of the box. Power increase of 4% required.
46	Left Wing Precontact[1]	None	230	20,000	8.8	2	1	Trim 6 deg left wing down 2 deg left rudder.
46.a		30 ft up				2	1	Very light airframe buffet from engine plume.
46.b		11 ft left				2	1	Trim 5 deg left wing down.
46.c		11 ft right				2	1	Trim 6 deg left wing down.

S-3B Flight 2 (Cont'd)

Point No.	Base Position	Position Deviation	Airspeed (KIAS)	Altitude (ft MSL)	Receiver Fuel Weight (K lb)	HQR	PIO	Receiver Pilot Comments
46.d	Left Wing Precontact[1]	11 ft left and 30 ft up	230	20,000	8.8	2	1	Very light airframe buffet from engine plume. Trim 7 deg left wing down. Holding lateral stick input (1 in. right) required.
46.e		11 ft right and 30 ft up				3	1	Moderate airframe buffet from engine plume. Same inputs as 46d.
46.f		Rectangle Pattern (CCW)				2	1	Very light airframe buffet from engine plume across the top of the box.
47	Left Wing FTZ[2]	None	230	20,000	8.7	2	1	Trim 7 deg left wing down 2 deg left rudder. Very light airframe buffet from engine plume.
47.a		20 ft up				2	1	Very light airframe buffet from engine plume.
47.b		11 ft left				2	1	
47.c		11 ft right				2	1	
47.d		11 ft left and 20 ft up				2	1	
47.e		11 ft right and 20 ft up				4	1	Heavy airframe buffet from engine. Did not make it to point 47.e.
47.f		Rectangle Pattern (CCW)				3	1	Airflow pulling in and down across the top of the box. Minimal lateral stick inputs (1 in. left) required. Power increase of 4% required.
48	Left Wing NFTZ[3]	None	230	20,000	8.5	2	1	Trim 7 deg left wing down 3 left rudder. Very light airframe buffet from engine plume.
48.a		10 ft up				3	1	Mild airframe buffet from engine plume. Holding lateral stick input (1 in. right) required. Power increase of 4% required.

S-3B Flight 2 (Cont'd)

Point No.	Base Position	Position Deviation	Airspeed (KIAS)	Altitude (ft MSL)	Receiver Fuel Weight (K lb)	HQR	PIO	Receiver Pilot Comments
48.b	Left Wing NFTZ[3]	11 ft left	230	20,000	8.5	2	1	
48.c		11 ft right				2	1	Very light airframe buffet from engine plume.
48.d		11 ft left and 10 ft up				2	1	
48.e		11 ft right and 10 ft up						Point skipped due to results at 47.e.
48.f		Rectangle Pattern (CW)				3	1	Airflow in upper left corner pulled in and down. Moderate airframe buffet from engine plume. Holding lateral stick input (1 in. left) plus (1 in.) inputs to cross the top of the box. Box inboard corner was cut short of 47.e due to results at 47.f.

NOTES: (1) Precontact position 100 ft aft and 40 ft below tailcone or wing station of the 767 aircraft, as appropriate. Horizontal position deviation based on pod line up line. Vertical position deviation based on tanker visual cues.
(2) FTZ 75 ft aft and 30 ft below tailcone or wing station of the 767 aircraft, as appropriate.
(3) NFTZ 50 ft aft and 20 ft below tailcone or wing station of the 767 aircraft, as appropriate.

HEAVY GROSS WEIGHT 767 PROXIMITY WITH S-3B TEST POINT MATRIX FLIGHT 3

Point No.	Base Position	Position Deviation	Airspeed (KIAS)	Altitude (ft MSL)	Receiver Fuel Weight (K lb)	HQR	PIO	Receiver Pilot Comments
1	Centerline Precontact[1]	None	230	10,000	14.0	2	1	Trim 1/2 deg right wing down rudder neutral.
1.a		30 ft up				2	1	Very light airframe buffet from engine plume.
1.b		10 ft left				2	1	
1.c		10 ft right				2	1	
1.d		10 ft left and 30 ft up				2	1	Very light airframe buffet from engine plume.
1.e		10 ft right and 30 ft up				2	1	Trim 2 deg right wing down. Very light airframe buffet from engine plume.
1.f		Rectangle Pattern (CW)				2	1	Very light airframe buffet from engine plume across the top of the box.
2	Centerline FTZ[2]	None	230	10,000	13.9	2	1	Trim 2 deg right wing down rudder neutral.
2.a		20 ft up				2	1	Very light airframe buffet from engine plume.
2.b		10 ft left				2	1	
2.c		10 ft right				2	1	
2.d		10 ft left and 20 ft up				2	1	Mild airframe buffet from engine plume.
2.e		10 ft right and 20 ft up				2	1	Mild airframe buffet from engine plume.
2.f		Rectangle Pattern (CW)				2	1	Mild airframe buffet from engine plume across top of the box. Power increase of 6% required.
3	Centerline NFTZ[3]	None	230	10,000	13.7	2	1	Trim 1 deg right wing down rudder neutral.
3.a		10 ft up				2	1	Very light airframe buffet from engine plume.
3.b		10 ft left				2	1	
3.c		10 ft right				2	1	
3.d		10 ft left and 10 ft up				2	1	Very light airframe buffet from engine plume.
3.e		10 ft right and 10 ft up				2	1	Mild airframe buffet from engine plume.

S-3B Flight 3 (Cont'd)

Point No.	Base Position	Position Deviation	Airspeed (KIAS)	Altitude (ft MSL)	Receiver Fuel Weight (K lb)	HQR	PIO	Receiver Pilot Comments
3.f	Centerline NFTZ[3]	Rectangle Pattern (CW)	230	10,000	13.7	2	1	Very light airframe buffet from engine plume across the top of the box. Power increase of 8% required.
4	Right Wing Precontact[1]	None	230	10,000	13.6	3	1	Trim 7 deg right wing down 2 deg right rudder. Holding lateral stick input (1 in. right) required.
4.a		30 ft up				4	1	Moderate airframe buffet from engine plume. Lateral stick inputs of up to 2 in./sec (right) were required.
4.b		11 ft right				2	1	
4.c		11 ft left				3	1	Holding lateral stick input (1 in. right) plus further input (1 in. right) required for station keeping.
4.d		11 ft right and 30 ft up				2	1	Mild airframe buffet from engine plume.
4.e		11 ft left and 30 ft up				4	2	Moderate airframe buffet from engine plume. Holding lateral stick input (1 in. right) plus further input (1 in. right) required for station keeping.
4.f		Rectangle Pattern (CW)				3	2	Airflow in upper left corner pulled aircraft in and down. Same buffet and input as 4.e. Power increase of 6% required.
5	Right Wing FTZ[2]	None	230	10,000	13.2	2	1	Trim 7 deg right wing down 4 deg right rudder. Very light airframe buffet from engine plume (light turbulence in the area).

S-3B Flight 3 (Cont'd)

Point No.	Base Position	Position Deviation	Airspeed (KIAS)	Altitude (ft MSL)	Receiver Fuel Weight (K lb)	HQR	PIO	Receiver Pilot Comments
5.a	Right Wing FTZ[2]	20 ft up	230	10,000	13.2	3	1	Holding lateral stick input (1 in. right) required. Very light airframe buffet from engine plume. Power increase of 4% required.
5.b		11 ft right				2	1	
5.c		11 ft left				2	1	Very light airframe buffet from engine plume.
5.d		11 ft right and 20 ft up				2	1	
5.e		11 ft left and 20 ft up				4	1	Moderate airframe buffet from engine plume. Holding lateral stick input (1 in. right) plus further input (1 in. right) required for station keeping.
5.f		Rectangle Pattern (CW)				3	1	Airflow in upper left corner pulled aircraft in and down. Same buffet and input as 5.e. Power increase of 6% required.
6	Right Wing NFTZ[3]	None	230	10,000	13.2	2	1	Trim 7 deg right wing down 5 deg right rudder. Holding lateral stick input (1 in. right) required. Very light airframe buffet from engine plume.
6.a		10 ft up				2	1	Very light airframe buffet from engine plume.
6.b		10 ft right				2	1	
6.c		10 ft left				2	1	Very light airframe buffet from engine plume.
6.d		10 ft right and 10 ft up				2	1	
6.e		10 ft left and 10 ft up				4	1	Moderate airframe buffet from engine plume. Holding lateral stick input (1 in. right) plus further input (1 in. right) required for station keeping.

S-3B Flight 3 (Cont'd)

Point No.	Base Position	Position Deviation	Airspeed (KIAS)	Altitude (ft MSL)	Receiver Fuel Weight (K lb)	HQR	PIO	Receiver Pilot Comments
6.f	Right Wing NFTZ[3]	Rectangle Pattern (CW)	230	10,000	13.2	3	1	Airflow in upper left corner pulled aircraft in and down. Same buffet and input as 6.e. Power increase of 6% required.
7	Centerline Precontact[1]	None	270	10,000	12.9	2	1	Trim 2 deg right wing down 1 deg right rudder. ITT 720 deg.
7.a		30 ft up				2	1	Very light airframe buffet from engine plume. ITT 755 deg (max) and not able to maintain position.
7.b		10 ft left				2	1	
7.c		10 ft right				2	1	
7.d		10 ft left and 30 ft up				2	1	Mild airframe buffet from engine plume. ITT 755 deg (max).
7.e		10 ft right and 30 ft up				2	1	Trim 3 deg right wing down. Mild airframe buffet from engine plume. ITT 755 deg (max).
7.f		Rectangle Pattern (CW)				2	1	Mild airframe buffet from engine plume across the top of the box. ITT 755 deg (max).
8	Centerline FTZ[2]	None	270	10,000	12.6	2	1	Trim 2.5 deg right wing down 3 deg right rudder. ITT 750 deg.
8.a		20 ft up				2	1	Mild airframe buffet from engine plume.
8.b		10 ft left				2	1	
8.c		10 ft right				2	1	
8.d		10 ft left and 20 ft up				2	1	Very light airframe buffet from engine plume.
8.e		10 ft right and 20 ft up				2	1	Trim 4 deg right wing down. Mild airframe buffet from engine plume.
8.f		Rectangle Pattern (CW)				2	1	Mild airframe buffet from engine plume across top of the box. Power increase to ITT 755 (max).

S-3B Flight 3 (Cont'd)

Point No.	Base Position	Position Deviation	Airspeed (KIAS)	Altitude (ft MSL)	Receiver Fuel Weight (K lb)	HQR	PIO	Receiver Pilot Comments
9	Centerline NFTZ[3]	None	265	10,000	12.7	2	1	Trim 3 deg right wing down 3 deg right rudder. ITT 700 deg.
9.a		10 ft up				2	1	Very light airframe buffet from engine plume.
9.b		10 ft left				2	1	Trim 2 deg right wing down.
9.c		10 ft right				2	1	Trim 3 deg right wing down.
9.d		10 ft left and 10 ft up				2	1	Trim 2 deg right wing down.
9.e		10 ft right and 10 ft up				2	1	Trim 3 deg right wing down.
9.f		Rectangle Pattern (CW)				2	1	Very light airframe buffet from engine plume across the top of the box. Power increase to ITT 755 (max).
10	Right Wing Precontact[1]	None	265	10,000	12.3	2	1	Trim 7 deg right wing down 3 deg right rudder. ITT 700 deg.
10.a		30 ft up				2	1	Very light airframe buffet from engine plume.
10.b		11 ft right				2	1	
10.c		11 ft left				2	1	
10.d		11 ft right and 30 ft up				2	1	Holding lateral stick input (1 in. right) required.
10.e		11 ft left and 30 ft up				3	1	Holding lateral stick input (1 in. right) plus further input (1 in. right) required for station keeping.
10.f		Rectangle Pattern (CW)				3	1	Moderate airframe buffet from engine plume. Airflow in upper left corner pulled aircraft in and down. Same buffet and input as 10.e.
11	Right Wing FTZ[2]	None	265	10,000	12.1	2	1	Trim 7 deg right wing down 3 deg right rudder. Holding lateral stick input (1 in. right) required.

S-3B Flight 3 (Cont'd)

Point No.	Base Position	Position Deviation	Airspeed (KIAS)	Altitude (ft MSL)	Receiver Fuel Weight (K lb)	HQR	PIO	Receiver Pilot Comments
11.a	Right Wing FTZ[2]	20 ft up	265	10,000	12.1	2	1	Very light airframe buffet from engine plume. Holding lateral stick input (1 in. right) plus further input (1 in. right) required for station keeping.
11.b		11 ft right				2	1	Very light airframe buffet from engine plume.
11.c		11 ft left				2	1	Very light airframe buffet from engine plume.
11.d		11 ft right and 20 ft up				2	1	Holding lateral stick input (1 in. right) required.
11.e		11 ft left and 20 ft up				3	1	Holding lateral stick input (1 in. right) plus further input (1 in. right) required for station keeping. Power increase to ITT 755 (max).
11.f		Rectangle Pattern (CW)				3	2	Mild airframe buffet from engine plume at point 11.e. Power increase to ITT 755 (max).
12	Right Wing NFTZ[3]	None	265	10,000	11.9	2	2	Trim 7 deg right wing down 3.5 deg right rudder. ITT 700.
12.a		10 ft up				2	2	Very light airframe buffet from engine plume. Airflow pulling in slightly.
12.b		10 ft right				2	1	
12.c		10 ft left				2	1	Holding lateral stick input (1/2 in. right) required. Mild airframe buffet from engine plume.
12.d		10 ft right and 10 ft up				2	1	Very light airframe buffet from engine plume. Kicked out of position (right) from wing vortex because too high.

S-3B Flight 3 (Cont'd)

Point No.	Base Position	Position Deviation	Airspeed (KIAS)	Altitude (ft MSL)	Receiver Fuel Weight (K lb)	HQR	PIO	Receiver Pilot Comments
12.e	Right Wing NFTZ[3]	10 ft left and 10 ft up	265	10,000	11.9	3	1	Mild airframe buffet from engine plume. Minimal lateral stick input (1 in. right) required.
12.f		Rectangle Pattern (CW)				3	1	Airflow in upper left corner pulled aircraft in and down. Same buffet and input as 12.e.
25	Centerline Precontact[1]	None	230	10,000	8.8	2	1	Trim 1 deg right wing down rudder neutral.
25.a		30 ft up				2	1	Very light airframe buffet from engine plume.
25.b		10 ft left				2	1	Trim 1.5 deg right wing down.
25.c		10 ft right				2	1	Trim 3 deg right wing down.
25.d		10 ft left and 30 ft up				2	1	Trim 2 deg right wing down. Mild airframe buffet from engine plume.
25.e		10 ft right and 30 ft up				2	1	Trim 3 deg right wing down. Mild airframe buffet from engine plume.
25.f		Rectangle Pattern (CW)				2	1	Mild airframe buffet from engine plume across the top of the box. Power increase of 2%.
26	Centerline FTZ[2]	None	230	10,000	8.8	2	1	Trim 1 deg right wing down rudder neutral.
26.a		20 ft up				2	1	Mild airframe buffet from engine plume.
26.b		10 ft left				2	1	
26.c		10 ft right				2	1	Trim 4 deg right wing down.
26.d		10 ft left and 20 ft up				2	1	Trim 5 deg right wing down. Mild airframe buffet from engine plume.
26.e		10 ft right and 20 ft up				2	1	Mild airframe buffet from engine plume.
26.f		Rectangle Pattern (CW)				2	1	Mild airframe buffet from engine plume across top of the box. Power increase of 4% required.

S-3B Flight 3 (Cont'd)

Point No.	Base Position	Position Deviation	Airspeed (KIAS)	Altitude (ft MSL)	Receiver Fuel Weight (K lb)	HQR	PIO	Receiver Pilot Comments
27	Centerline NFTZ[3]	None	230	10,000	8.6	2	1	Trim 1.5 deg right wing down 2 deg right rudder.
27.a		10 ft up				2	1	Mild airframe buffet from engine plume.
27.b		10 ft left				2	1	Trim 1 deg right wing down.
27.c		10 ft right				2	1	Trim 3.5 deg right wing down.
27.d		10 ft left and 10 ft up				2	1	Trim 2 deg right wing down. Mild airframe buffet from engine plume.
27.e		10 ft right and 10 ft up				2	1	Trim 4 deg right wing down. Mild airframe buffet from engine plume.
27.f		Rectangle Pattern (CW)				2	1	Mild airframe buffet from engine plume across the top of the box. Power increase of 4% required.
28	Right Wing Precontact[1]	None	230	10,000	8.3	2	1	Trim 7 deg right wing down 3 deg right rudder. Holding lateral stick input (1 in. right) required.
28.a		30 ft up				2	1	Very light airframe buffet from engine plume.
28.b		11 ft right				2	1	
28.c		11 ft left				2	1	
28.d		11 ft right and 30 ft up				2	1	
28.e		11 ft left and 30 ft up				2	1	Very light airframe buffet from engine plume.
28.f		Rectangle Pattern (CW)				2	1	Very light airframe buffet from engine plume across top of the box. Power increase of 6% required.
29	Right Wing FTZ[2]	None	230	10,000	8.0	2	1	Trim 7 deg right wing down 3 deg right rudder. Holding lateral stick input (1 in. right) required.
29.a		20 ft up				2	1	Very light airframe buffet from engine plume.

S-3B Flight 3 (Cont'd)

Point No.	Base Position	Position Deviation	Airspeed (KIAS)	Altitude (ft MSL)	Receiver Fuel Weight (K lb)	HQR	PIO	Receiver Pilot Comments
29.b	Right Wing FTZ[2]	11 ft right	230	10,000	8.0	2	1	
29.c		11 ft left				2	1	
29.d		11 ft right and 20 ft up				2	1	
29.e		11 ft left and 20 ft up				2	1	Mild airframe buffet from engine plume.
29.f		Rectangle Pattern (CW)				3	1	Mild airframe buffet from engine plume across the top of the box. Holding lateral stick input (1 in. right) plus (1 in) inputs to cross the top of the box. Power increase of 8% required.
30	Right Wing NFTZ[3]	None	230	10,000	7.9	2	1	Trim 7 deg right wing down 1 deg right rudder. Holding lateral stick input (1 in. right) required.
30.a		10 ft up				3	1	Holding lateral stick input (1 in. right) plus further input (1 in. right per sec) required for station keeping. Airflow pulling in.
30.b		10 ft right				2	1	
30.c		10 ft left				2	1	Very light airframe buffet from engine plume.
30.d		10 ft right and 10 ft up				2	1	Holding lateral stick input (1 in. right) plus further input (1 in. right per sec) required for station keeping. Airflow pulling in.
30.e		10 ft left and 10 ft up				3	1	Moderate airframe buffet from engine plume. Holding lateral stick input (1 in. right) plus further input (1 in. right) required for station keeping.

S-3B Flight 3 (Cont'd)

Point No.	Base Position	Position Deviation	Airspeed (KIAS)	Altitude (ft MSL)	Receiver Fuel Weight (K lb)	HQR	PIO	Receiver Pilot Comments
30.f	Right Wing NFTZ[3]	Rectangle Pattern (CW)	230	10,000	7.9	3	1	Airflow in upper left corner pulled aircraft in and down. Same buffet and input as 30.e. Power increase of 6% required.

NOTES: (1) Precontact position 100 ft aft and 40 ft below tailcone or wing station of the 767 aircraft, as appropriate. Horizontal position deviation based on pod line up line. Vertical position deviation based on tanker visual cues.
(2) FTZ 75 ft aft and 30 ft below tailcone or wing station of the 767 aircraft, as appropriate.
(3) NFTZ 50 ft aft and 20 ft below tailcone or wing station of the 767 aircraft, as appropriate.

LIGHT GROSS WEIGHT 767 PROXIMITY WITH F/A-18 TEST POINT MATRIX FLIGHT 1

Point No.	Base Position	Position Deviation	Airspeed (KIAS)	Altitude (ft MSL)	Receiver Fuel Weight (K lb)	HQR	PIO	Receiver Pilot Comments
1	Centerline Precontact[1]	None	270	19,000	12.2	2	1	
1.a		30 ft up		20,000		2	1	
1.b		10 ft left				2	1	Minor lateral trim change.
1.c		10 ft right				2	1	Minor lateral trim change.
1.d		30 ft up and 10 ft left				2	1	Minor lateral trim change.
1.e		30 ft up and 10 ft right				2	1	Minor lateral trim change.
1.f		Rectangle Pattern				2	1	
2	Centerline FTZ[2]	None	270	20,000	11.5	2	1	
2.a		20 ft up				2	1	
2.b		10 ft left				2	1	Minor lateral trim change.
2.c		10 ft right				2	1	Minor lateral trim change.
2.d		20 ft up and 10 ft left				2	1	Minor lateral trim change and mild engine plume buffet.
2.e		30 ft up and 10 ft right				2	1	Minor lateral trim change and mild engine plume buffet.
2.f		Rectangle Pattern				2	1	
3	Centerline NFTZ[3]	None	270	20,000	10.4	2	1	
3.a		10 ft up				2	1	
3.b		10 ft left				2	1	5 lateral trim clicks left.
3.c		10 ft right				2	1	5 lateral trim clicks right.
3.d		10 ft up and 10 ft left				2	1	5 lateral trim clicks left and mild engine plume buffet.
3.e		10 ft up and 10 ft right				2	1	5 lateral trim clicks left and mild engine plume buffet.
3.f		Rectangle Pattern				2	1	
4	Right Wing Precontact[1]	None	270	20,000	9.7	2	1	
4.a		30 ft up				2	1	
4.b		11 ft right				2	1	
4.c		11 ft left				2	1	
4.d		30 ft up and 11 ft right				2	1	
4.e		30 ft up and 11 ft left				2	1	Mild engine buffet.
4.f		Rectangle Pattern				2	1	
5	Right Wing FTZ[2]	None	270	20,000	9.3	2	1	
5.a		20 ft up				2	1	
5.b		11 ft right				2	1	8 clicks right trim.

F/A-18C Flight 1 (Cont'd)

Point No.	Base Position	Position Deviation	Airspeed (KIAS)	Altitude (ft MSL)	Receiver Fuel Weight (K lb)	HQR	PIO	Receiver Pilot Comments
5.c	Right Wing FTZ[2]	11 ft left	270	20,000	9.3	2	1	5 clicks left trim.
5.d		20 ft up and 11 ft right				3	1	8 clicks right trim. Left yaw and right sideforce threshold of wingtip vortex.
5.e		20 ft up and 11 ft left				2	1	5 clicks left trim and engine buffet.
5.f		Rectangle Pattern				3	1	Upper right extreme see above.
6	Right Wing NFTZ[3]	None	270	20,000	8.5	2	1	
6.a		10 ft up				2	1	
6.b		11 ft right				2	1	8 clicks right trim.
6.c		11 ft left				2	1	5 clicks left trim.
6.d		10 ft up and 11 ft right				3	1	8 clicks right trim. Left yaw and right sideforce threshold of wingtip vortex.
6.e		10 ft up and 11 ft left				2	1	5 clicks left trim and engine buffet.
6.f		Rectangle Pattern				3	1	Upper right extreme see above.
19	Centerline Precontact[1]	None	270	20,000	7.4	2	1	Same as run 1 but at lighter weight. Same flying qualities.
19.a		30 ft up				2	1	
19.b		10 ft left				2	1	Minor lateral trim change.
19.c		10 ft right				2	1	Minor lateral trim change.
19.d		30 ft up and 10 ft left				2	1	Minor lateral trim change.
19.e		30 ft up and 10 ft right				2	1	Minor lateral trim change.
19.f		Rectangle Pattern				2	1	

NOTES: (1) Precontact position 100 ft aft and 40 ft below tailcone or wing station of the 767 aircraft, as appropriate. Horizontal position deviation based on pod line up line. Vertical position deviation based on tanker visual cues.

(2) FTZ 75 ft aft and 30 ft below tailcone or wing station of the 767 aircraft, as appropriate.

(3) NFTZ 50 ft aft and 20 ft below tailcone or wing station of the 767 aircraft, as appropriate.

HEAVY GROSS WEIGHT 767 PROXIMITY WITH F/A-18 TEST POINT MATRIX
FLIGHT 2

Point No.	Base Position	Position Deviation	Airspeed (KIAS)	Altitude (ft MSL)	Receiver Fuel Weight (K lb)	HQR	PIO	Receiver Pilot Comments
7	Left Wing Precontact[1]	None	270	19,000	13.2	2	1	
7.a		30 ft up		20,000		2	1	
7.b		11 ft left				2	1	
7.c		11 ft right				2	1	
7.d		30 ft up and 11 ft left				2	1	
7.e		30 ft up and 11 ft right				2	1	Minor airframe vibration.
7.f		Rectangle Pattern				2	1	
8	Left Wing FTZ[2]	None	270	20,000	12.6	2	1	
8.a		20 ft up				2	1	Jet wanted to roll right, 1-2 clicks left lateral trim.
8.b		11 ft left				2	1	Wanted to roll right.
8.c		11 ft right				2	1	
8.d		20 ft up and 11 ft left				2	1	
8.e		20 ft up and 11 ft right				2	1	
8.f		Rectangle Pattern				2	1	
9	Left Wing NFTZ[3]	None	270	20,000	12.0	2	1	
9.a		10 ft up				2	1	
9.b		11 ft left				2	1	
9.c		11 ft right				2	1	
9.d		10 ft up and 11 ft left				2	1	
9.e		10 ft up and 11 ft right				2	1	
9.f		Rectangle Pattern				2	1	
10	Centerline Precontact[1]	None	325	20,000	11.0	2	1	
10 a		30 ft up				2	1	
10.b		10 ft left				2	1	
10.c		10 ft right				2	1	
10.d		30 ft up and 10 ft left				3	1	Mild airframe buffet.
10.e		30 ft up and 10 ft right				3	1	
10.f		Rectangle Pattern				2	1	HQR's of 3 in upper corners.
11	Centerline FTZ[2]	None	325	20,000	10.5	2	1	
11.a		20 ft up				2	1	
11.b		10 ft left				2	1	
11.c		10 ft right				2	1	
11.d		20 ft up and 10 ft left				2	1	Mild airframe buffet.

F/A-18C Flight 2 (Cont'd)

Point No.	Base Position	Position Deviation	Airspeed (KIAS)	Altitude (ft MSL)	Receiver Fuel Weight (K lb)	HQR	PIO	Receiver Pilot Comments
11.e		20 ft up and 10 ft right				2	1	Mild airframe buffet.
11.f		Rectangle Pattern				2	1	
12	Centerline NFTZ[3]	None	325	20,000	10.0	2	1	
12.a		10 ft up				2	1	Airframe rumble.
12.b		10 ft left				2	1	
12.c		10 ft right				2	1	
12.d		10 ft up and 10 ft left				2	1	Airframe rumble.
12.e		10 ft up and 10 ft right				2	1	Airframe rumble.
12.f		Rectangle Pattern				2	1	Rumble at top outside corners.
13	Right Wing Precontact[1]	None	325	20,000	9.4	2	1	
13.a		30 ft up				2	1	Wants to roll left. 2-3 clicks of right lateral trim required.
13.b		11 ft right				2	1	
13.c		11 ft left				2	1	
13.d		30 ft up and 11 ft right				2	1	
13.e		30 ft up and 11 ft left				2	1	1-2 clicks right lateral trim.
13.f		Rectangle Pattern				2	1	Left upper corner wants to roll into tanker.
14	Right Wing FTZ[2]	None	325	20,000	8.9	2	1	
14.a		20 ft up				2	1	
14.b		11 ft right				2	1	
14.c		11 ft left				2	1	
14.d		20 ft up and 11 ft right				2	1	
14.e		20 ft up and 11 ft left				2	1	1-2 clicks right lateral trim.
14.f		Rectangle Pattern				2	1	Harder during the turn.
15	Right Wing NFTZ[3]	None	325	20,000	7.9	2	1	
15.a		10 ft up				2	1	Slight tendency to pull to the left.
15.b		11 ft right				2	1	Wants to roll right away from tanker.
15.c		11 ft left				2	1	
15.d		10 ft up and 11 ft right				2	1	
15.e		10 ft up and 11 ft left				2	1	1-2 clicks right lateral trim.
15.f		Rectangle Pattern				2	1	
31	Right Wing Precontact[1]	None	220	20,000	7.3	2	1	
31.a		30 ft up				2	1	
31.b		11 ft right				2	1	Slight tendency to roll away.

F/A-18C Flight 2 (Cont'd)

Point No.	Base Position	Position Deviation	Airspeed (KIAS)	Altitude (ft MSL)	Receiver Fuel Weight (K lb)	HQR	PIO	Receiver Pilot Comments
31.c		11 ft left				2	1	
31.d		30 ft up and 11 ft right				2	1	
31.e	Right Wing Precontact[1]	30 ft up and 11 ft left	220	20,000	7.3	2	1	Slight tendency to roll into.
31.f		Rectangle Pattern				2	1	
32	Right Wing FTZ[2]	None	220	20,000	6.9	2	1	
32.a		20 ft up				2	1	Slight tendency to roll away.
32.b		11 ft right				2	1	
32.c		11 ft left				2	1	
32.d		20 ft up and 11 ft right				2	1	
32.e		20 ft up and 11 ft left				2	1	
32.f		Rectangle Pattern				2	1	
33	Right Wing NFTZ[3]	None	220	20,000	6.6	2	1	
33.a		10 ft up				2	1	Slight tendency to roll into.
33.b		11 ft right				2	1	
33.c		11 ft left				2	1	
33.d		10 ft up and 11 ft right				2	1	
33.e		10 ft up and 11 ft left				2	1	
33.f		Rectangle Pattern				2	1	

NOTES: (1) Precontact position 100 ft aft and 40 ft below tailcone or wing station of the 767 aircraft, as appropriate. Horizontal position deviation based on pod line up line. Vertical position deviation based on tanker visual cues.
(2) FTZ 75 ft aft and 30 ft below tailcone or wing station of the 767 aircraft, as appropriate.
(3) NFTZ 50 ft aft and 20 ft below tailcone or wing station of the 767 aircraft, as appropriate.

HEAVY GROSS WEIGHT 767 PROXIMITY WITH F/A-18 TEST POINT MATRIX FLIGHT 3

Point No.	Base Position	Position Deviation	Airspeed (KIAS)	Altitude (ft MSL)	Receiver Fuel Weight (K lb)	HQR	PIO	Receiver Pilot Comments
1	Centerline Precontact[1]	None	270	20,000	~ 13,600	2	1	
1.a		30 ft up				2	1	
1.b		10 ft left				2	1	
1.c		10 ft right				2	1	
1.d		10 ft left and 30 ft up				2	1	
1.e		10 ft right and 30 ft up				2	1	
1.f		Rectangle Pattern				2	1	
2	Centerline FTZ[2]	None	270	20,000	Not recorded	2	1	
2.a		20 ft up				2	1	
2.b		10 ft left				2	1	
2.c		10 ft right				2	1	Mild lateral inputs, no adverse buffet/forces felt on aircraft.
2.d		10 ft left and 20 ft up				2	1	Slight airframe buffet on vertical tails.
2.e		10 ft right and 20 ft up				2	1	
2.f		Rectangle Pattern				2	1	Slight airframe buffet on vertical tails at top position.
3	Centerline NFTZ[3]	None	270	20,000	~12,600	2	1	
3.a		10 ft up				2	1	
3.b		10 ft left				2	1	
3.c		10 ft right				2	1	
3.d		10 ft left and 10 ft up				2	1	Mild lateral/longitudinal inputs.
3.e		10 ft right and 10 ft up				2	1	
3.f		Rectangle Pattern				2	1	
4	Right Wing Precontact[1]	None	270	20,000	~12,400	2	1	
4.a		30 ft up				2	1	
4.b		11 ft right				2	1	
4.c		11 ft left				2	1	
4.d		11 ft right and 30 ft up				2	1	
4.e		11 ft left and 30 ft up				2	1	Light right lateral stick force required to counteract left roll.
4.f		Rectangle Pattern				2	1	
5	Right Wing FTZ[2]	None	270	20,000	~12,200	2	1	
5.a		20 ft up				2	1	

F/A-18C Flight 3 (Cont'd)

Point No.	Base Position	Position Deviation	Airspeed (KIAS)	Altitude (ft MSL)	Receiver Fuel Weight (K lb)	HQR	PIO	Receiver Pilot Comments
5.b	Right Wing FTZ[2]	11 ft right	270	20,000	~12,200	2	1	
5.c		11 ft left				2	1	
5.d		11 ft right and 20 ft up				2	1	Mild lateral/longitudinal inputs. Light burble.
5.e		11 ft left and 20 ft up				2	1	Light right lateral stick force required to counteract left roll.
5.f		Rectangle Pattern				2	1	
6	Right Wing NFTZ[3]	None	270	20,000	~11,500	2	1	
6.a		10 ft up				2	1	
6.b		11 ft right				2	1	
6.c		11 ft left				2	1	
6.d		11 ft right and 10 ft up				2	1	
6.e		11 ft left and 10 ft up				2	1	
6.f		Rectangle Pattern				2	1	
13	Right Wing Precontact[1]	None	325	20,000	~10,800	2	1	
13.a		30 ft up				2	1	
13.b		11 ft right				2	1	
13.c		11 ft left				2	1	
13.d		11 ft right and 30 ft up				2	1	
13.e		11 ft left and 30 ft up				2	1	
13.f		Rectangle Pattern				2	1	
14	Right Wing FTZ[2]	None	325	20,000	~10,200	2	1	
14.a		20 ft up				2	1	
14.b		11 ft right				2	1	
14.c		11 ft left				2	1	
14.d		11 ft right and 20 ft up				2	1	
14.e		11 ft left and 20 ft up				2	1	Light right lateral stick force required to counteract left roll.
14.f		Rectangle Pattern				2	1	
15	Right Wing NFTZ[3]	None	325	20,000	~9,800	2	1	
15.a		10 ft up				2	1	
15.b		11 ft right				2	1	
15.c		11 ft left				3	1	Light right lateral stick force required to counteract left roll plus mild burble

F/A-18C Flight 3 (Cont'd)

Point No.	Base Position	Position Deviation	Airspeed (KIAS)	Altitude (ft MSL)	Receiver Fuel Weight (K lb)	HQR	PIO	Receiver Pilot Comments
15.d	Right Wing NFTZ[3]	11 ft right and 10 ft up	325	20,000	~9,800	2	1	
15.e		11 ft left and 10 ft up				3	1	Light right lateral stick force required to counteract left roll plus mild burble
15.f		Rectangle Pattern				3	1	Light right lateral stick force required to counteract left roll plus mild burble (at left/left high position).
43	Centerline Precontact[1]	None	220	20,000	~7,200	2	1	
43.a		30 ft up				2	1	
43.b		10 ft left				2	1	
43.c		10 ft right				2	1	
43.d		10 ft left and 30 ft up				2	1	
43.e		10 ft right and 30 ft up				2	1	
43.f		Rectangle Pattern				2	1	
44	Centerline FTZ[2]	None	220	20,000	~6,900	2	1	
44.a		20 ft up				2	1	
44.b		10 ft left				2	1	
44.c		10 ft right				2	1	
44.d		10 ft left and 20 ft up				2	1	
44.e		10 ft right and 20 ft up				2	1	
44.f		Rectangle Pattern				2	1	
45	Centerline NFTZ[3]	None	220	20,000	~6,600	2	1	
45.a		10 ft up				2	1	
453.b		10 ft left				2	1	
45.c		10 ft right				2	1	
45.d		10 ft left and 10 ft up				2	1	
45.e		10 ft right and 10 ft up				2	1	
45.f		Rectangle Pattern				2	1	
46	Right Wing Precontact[1]	None	220	20,000	~6,400	2	1	
46.a		30 ft up				2	1	
46.b		11 ft right				2	1	
46.c		11 ft left				2	1	
46.d		11 ft right and 30 ft up				2	1	
46.e		11 ft left and 30 ft up				2	1	
46.f		Rectangle Pattern				2	1	

F/A-18C Flight 3 (Cont'd)

Point No.	Base Position	Position Deviation	Airspeed (KIAS)	Altitude (ft MSL)	Receiver Fuel Weight (K lb)	HQR	PIO	Receiver Pilot Comments
47	Right Wing FTZ[2]	None	220	20,000	~6,100	2	1	
47.a		20 ft up				2	1	
47.b		11 ft right				2	1	
47.c		11 ft left				2	1	
47.d		11 ft right and 20 ft up				2	1	
47.e		11 ft left and 20 ft up				2	1	
47.f		Rectangle Pattern				2	1	
48	Right Wing NFTZ[3]	None	220	20,000	~5,800	2	1	
48.a		10 ft up				2	1	
48.b		11 ft right				2	1	
48.c		11 ft left				2	1	
48.d		11 ft right and 10 ft up				2	1	
48.e		11 ft left and 10 ft up				2	1	
48.f		Rectangle Pattern				2	1	

NOTES: (1) Precontact position 100 ft aft and 40 ft below tailcone or wing station of the 767 aircraft, as appropriate. Horizontal position deviation based on pod line up line. Vertical position deviation based on tanker visual cues.
(2) FTZ 75 ft aft and 30 ft below tailcone or wing station of the 767 aircraft, as appropriate.
(3) NFTZ 50 ft aft and 20 ft below tailcone or wing station of the 767 aircraft, as appropriate.

APPENDIX D
COOPER-HARPER AND PILOT INDUCED OSCILLATION RATING SCALE

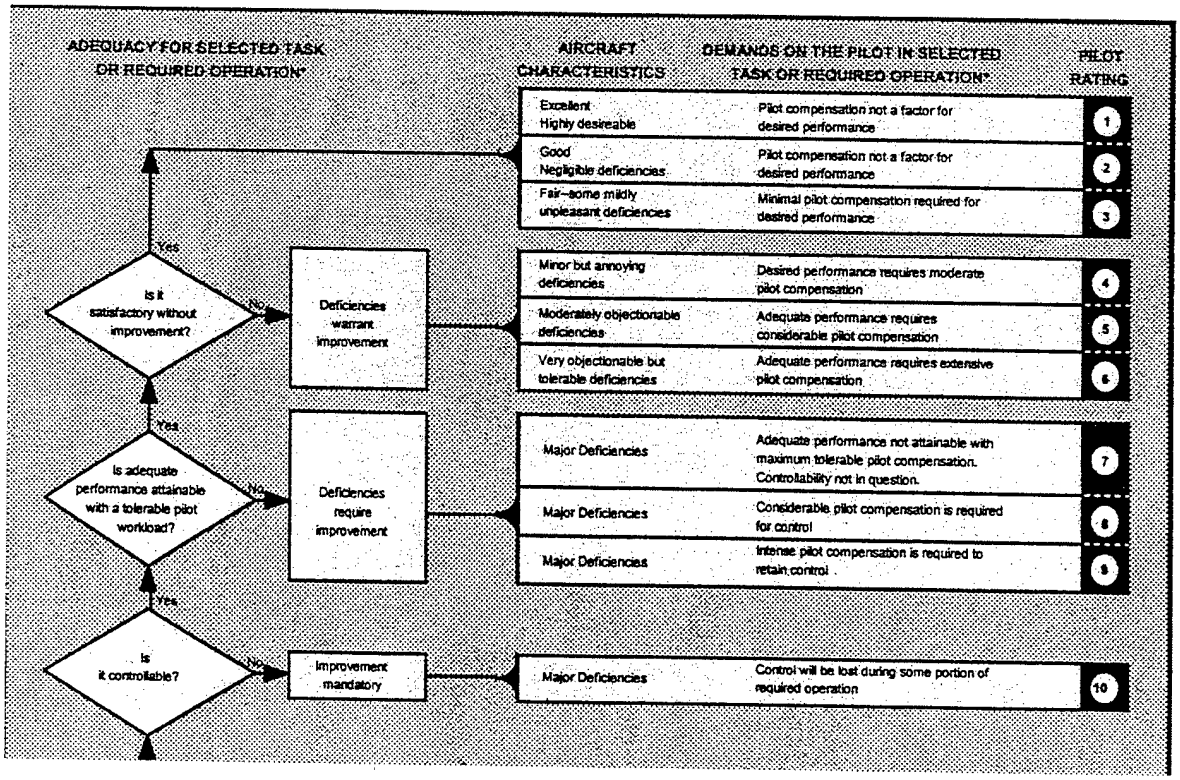

Figure D-1: Cooper-Harper HQR Scale

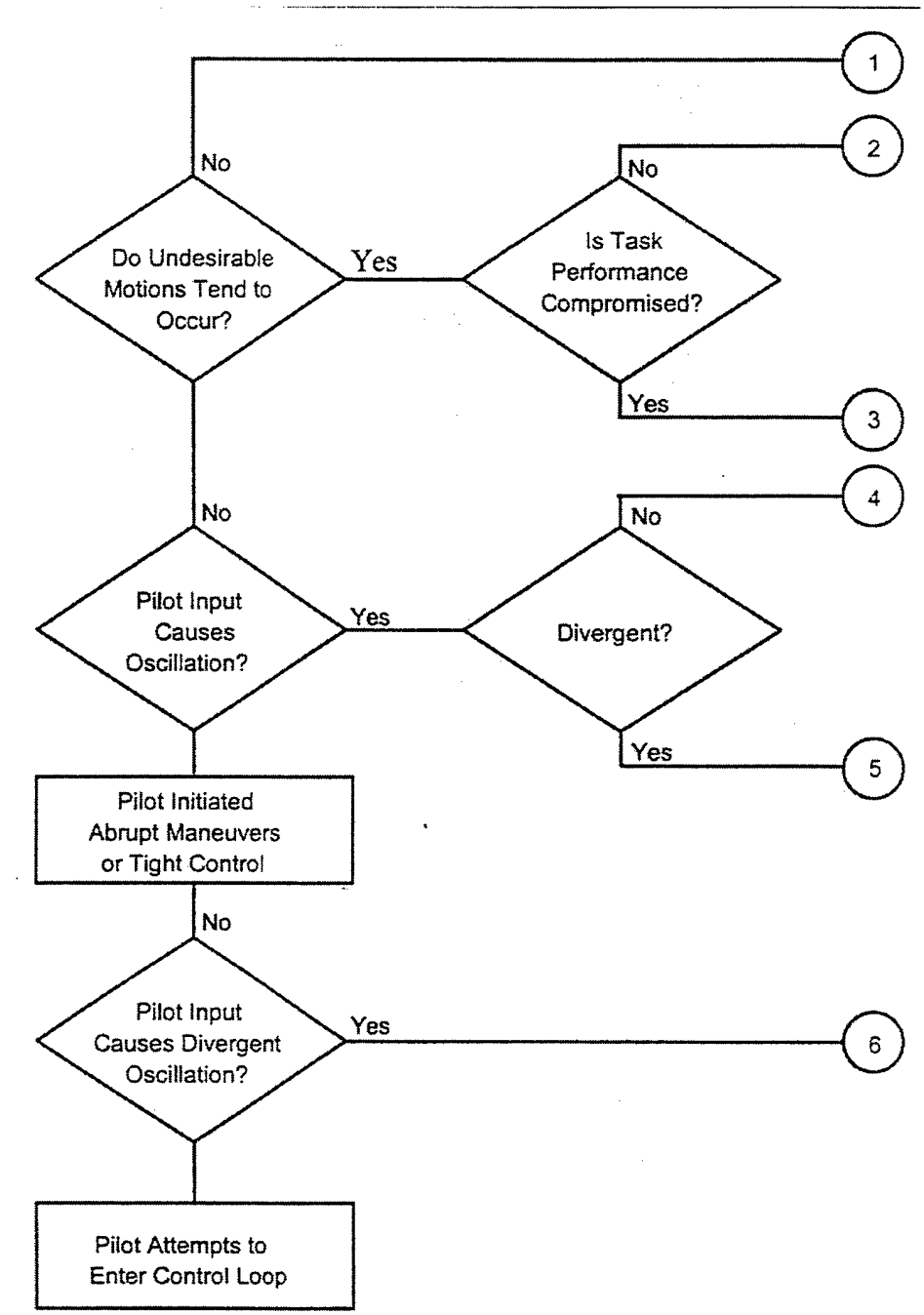

Figure D-2: PIO's Rating Scale

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